SCIENCE

VOL. 73 FRIDAY, MARCH 20, 1931 No. 1890

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE NEW CYTOLOGY[1]

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CYTOLOGY, if its full significance is given to this term, is the science concerned with cells and tissues, their functions as well as their structure. Such was the conception of Schwann. He considered the living organism as dependent on both metabolic and plastic activities of the cells. But his followers ignored this point of view. They contented themselves with the study of the form, and overlooked that of the function. On account of this fundamental error, the work done for nearly a century by a host of cytologists and histologists has ended in an incomplete science of the cells and the tissues. This science does not show how such cells and tissues are building up organized beings. It is also unable to give an explanation for the most common pathological phenomena, such as the cicatrization of a wound or the growth of a tumor.

[1] From the laboratories of The Rockefeller Institute for Medical Research.

The unsatisfactory nature of our knowledge of the elements of the body must undoubtedly be attributed to the conception on which classical histology is based. Whether dead or living, dissociated on a slide or explanted in a drop of plasma, or sectioned and stained, cells and tissues have been considered as inert forms, unrelated to their environment and deprived of functional activity. They have been abstracted from both space and time. In fact, they have been stripped from their reality. Obviously, the traditional conception has to be given up. In order to replace it by another abstraction containing a larger part of truth, one must return to the close observation of the concrete event which a tissue is.

The first notion gained from this analysis is that cells are in physiological continuity with their environment. Cells and environment form a whole. A cell depends as strictly upon its medium as the nucleus

upon the cytoplasm. Almost a century ago, Schwann described the cells as surrounded by a fluid, the cytoblastema, containing the material required for their nutrition. Later, Claude Bernard demonstrated the capital importance of internal environment in the life of the body. Physiology, according to his conception, is based both on the properties of tissues and on the physicochemical conditions of the internal environment, or organic medium. The organic medium is secreted by the tissues and, in its turn, regulates their activity. To a given constitution of the medium corresponds a certain morphological and functional state of the cells. But each cell type responds in its own way to a same environment. We may assume that the state of a tissue rests simultaneously on its hereditary properties and previous history, and on the conditions of its medium. The morphological description of cells of a given type acquires its full significance only when the environment is accurately defined. It is necessary to substitute for the conception of cells and tissues abstracted from their surroundings and isolated in space that of a system cells-medium, and to study at the same time the constituent parts of this system.

Secondly, structure and function are two aspects of the same thing. One can not consider them separately. Each structural detail possesses its functional expression. It is through the physiological aptitudes of their anatomical parts that the life of the higher animals is rendered possible. Likewise, the life of a community of ants depends on the physiological aptitudes of the individuals of which it is composed. When cells are considered only as structural elements, they are deprived of all the properties that make them capable of organizing as a living whole. Within the organism, they are associated according to certain laws. Cell sociology results from properties specific to each cell type. Among these properties, some manifest themselves under ordinary conditions of life, while others remain hidden. Tissues are endowed with potentialities far greater than those which are apparent. But these potentialities become actualized only when certain modifications of the internal environment occur, as, for instance, when pathogenic agencies are at work within the body. The significance of a given structural state is bound to the knowledge of the corresponding physiological state. Structure and function must be considered simultaneously.

Thirdly, a tissue is evidently an enduring thing. Its functional and structural conditions become modified from moment to moment. Time is really the fourth dimension of living organisms. It enters as a part into the constitution of a tissue. Cell colonies, or organs, are events which progressively unfold themselves. They must be studied like history. A tissue consists of a society of complex organisms which does not respond in an instantaneous manner to the changes of the environment. It may oppose such changes for a long time before adapting itself to the new conditions through slight or profound transformations. To study it at only one instant of the duration is almost meaningless. The temporal extension of a tissue is as important as its spatial existence.

To summarize: The conception of the cells and of the tissues, which I propose to substitute for the classical one, is that of a system cells-environment, of which the structural, functional, physical, physicochemical and chemical conditions are considered in time as well as in space.

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The reconstruction of cytology, according to this conception, has required a radical transformation of the method. For this method only reaches the mental constructs that were considered as being the anatomical elements. Even when dealing with tissues still alive in the animal body or explanted *in vitro*, it remains confined to the realm of inanimate matter. The new method consists of a body of techniques through which the system cells-environment is apprehended in both its structural and functional aspects. It is based on the property of cells to remain alive *in vitro* when certain conditions are provided for them. There are two ways of preventing the death of tissues and organs removed from the organism. One was originated by Ludwig and the other by Harrison. Ludwig supplied the blood vessels of an excised organ with artificial circulation of a proper fluid. Thus he obtained the survival of glands for a number of hours. Although this procedure, more or less modified, has been used for a long time in many kinds of physiological experiments, it has remained too crude to allow entire organs to be cultivated *in vitro*. It seems, however, that parts of the body perfused with a nutrient fluid under proper conditions could be kept alive outside of the body for several weeks. By the combined use of the Rosenberger magnetic pump, of a respiratory chamber and of the aseptic techniques developed for the transplantation of organs and limbs, the old method of the physiologists of the nineteenth century is being rejuvenated, and may become one of the most useful tools of the new cytology. The second and simpler manner of keeping tissues alive *in vitro* is to reduce them to small fragments and, instead of utilizing the natural avenues of circulation, to feed them by diffusion from a nutritive medium brought into close contact with the cells. This technique was invented by Harrison more than twenty

years ago. Small portions of various tissues of the frog embryo were placed in a drop of lymph suspended over a hollow side. The lymph coagulated. During the following days, Harrison observed the formation of protoplasmic processes from the cells of the neural tube, and the differentiation of muscle fibers from the myotomes. Thus the truth of the histogenetic theory of nerve outgrowth was demonstrated, as well as the important fact that highly differentiated tissues can grow *in vitro* for several weeks. These admirable experiments, described in 1908 in a Harvey Lecture by Harrison himself, convinced me of the possibility of studying the effect of environment on cell multiplication in tissues growing *in vitro*. But from the early technique to the present method, the road has been very long. The original procedure of Harrison, although perfectly adapted to its purpose, did not allow the tissues to be maintained under constant conditions and their properties to be analyzed. Other and more powerful techniques had to be developed. This work required many years. Progressively, a number of procedures were elaborated which render possible the investigation of the relations of tissues and their environment.

The purpose of a first group of procedures is to obtain pure strains of the main cell types. Cytological as well as bacteriological studies must be made on cellular or bacterial colonies free from contamination by organisms of other types. The use of pure cultures is imperative. No reliable information can be gained from fragments of fresh tissues consisting of a heterogeneous mixture of cells. When the properties of a given cell type are under investigation, the colonies should be composed exclusively of cells belonging to this type. Such colonies are obtained either by mechanically isolating a group of cells which have migrated into the coagulum or by utilizing the selective effects of certain poisons, or of a proper diet, on cell multiplication. The species which have so far been isolated in a pure state are: tissue macrophages and fibroblasts (Carrel), cartilage cells (Fischer), iris epithelium (Fischer), blood macrophages (Carrel), thyroid epithelium (Ebeling), crystalline epithelium (Kirby), hepatic epithelium (Doljanski) and fibroblasts from cartilage, muscle, bone, etc., (Fischer, Doljanski, Parker). Several types of malignant cells have also been obtained in pure cultures: macrophages and fibroblasts of Rous sarcoma (Carrel), fibroblasts of sarcoma 10 of the Crocker Foundation and of Jensen sarcoma (Carrel), epithelium of Ehrlich carcinoma (Fischer), and epithelium of spontaneous cancers of the mouse (Carrel, Santesson). Most of these strains are capable of living indefinitely *in vitro*. The colonies are kept for experimental purposes just as bacterial strains are.

A second group of procedures has been developed for maintaining the tissues in media of unvarying composition. In the hanging drop technique, the medium undergoes profound changes from moment to moment under the influence of the tissue. Such marked variations are prevented by greatly increasing the volume of the medium relatively to that of the colony. The medium is contained in flasks where the tissues are effectively protected against bacterial infection. It is composed of three parts: solid, fluid and gaseous. The solid part is made of a fibrin coagulum, used by the cells as a scaffold. On its surface is placed the fluid medium containing the nutrient substances which reach the culture by diffusion. The proper physicochemical conditions, such as osmotic tension, H-ion concentration, etc., can be regulated at will. The gaseous atmosphere is made up of a mixture of oxygen, carbon dioxide and nitrogen, the proportions of which are varied according to the nature of the experiment. Since the fluid and gaseous media are several thousand times larger in volume than the tissues, they undergo only slight changes. When, after several days, these changes become noticeable, the fluid is removed, the coagulum washed with Tyrode solution, and a fresh nutrient medium added. If a larger amount of medium is needed, the apparatus of de Haan may be employed. A simpler way of circulating fluid at the surface of the tissues is to use flasks with lateral wings. These flasks are placed on an oscillating platform. At each oscillation, the fluid washes the surface of the coagulum, and prevents the local accumulation of catabolites. More elaborate culture chambers have been constructed in which the coagulum is covered by a thin stream of nutrient fluid. In this manner, a large volume of medium can be used without interfering with the respiration of the tissues. The changes that occur in the composition of the fluid and gaseous media are easily ascertained by ordinary chemical methods.

The techniques used for the preparation of the media form a third group. They consist of the ordinary physicochemical and chemical procedures. However, the chemical techniques differ slightly from the usual ones, because the substances must be handled under aseptic conditions and without being denatured (Baker). Many types of media are used: Tyrode solution and other saline solutions, blood serum, heparined plasma, juice of embryonic tissues, solutions of embryonic proteins, extract of bone marrow and of adult organs, proteins of different natures, products of the more or less complete hydrolysis of a number of animal and vegetal proteins, solutions of amino acids, nucleic acid, glycocoll, glutathione, hydrogen sulfide, sodium sulfide, hemoglobin, methemoglobin,

pepsin, erepsin, trypsin, peroxidase, catalase, ferments extracted from spleen, liver, muscle and from malignant tumors, lipoids from plasma and various organs, etc.

The structural and physiological conditions of the cell colonies are investigated by means of a fourth group of procedures, comprising the classical cytological and histological techniques with their recent acquisitions, and a series of newer physiological techniques. The measurement of the residual growth energy and of the rate of growth, and the estimation of oxygen, glucose, lactic acid, carbon dioxide, proteolytic ferments, protein split-products and other growth-activating substances used or produced by the tissues give some precise information about the physiological activities corresponding to a given morphological state. The response of the main cell types to various toxic and nutrient substances is also ascertained through the qualitative and quantitative variations of the colonies.

Cinematography was applied for the first time to the study of tissues living *in vitro* by Comandon. Later, Fabbri and Ebeling succeeded in filming the growth of pure cultures of fibroblasts. During the last six years, Ebeling and Rosenberger have systematically used this method in an investigation of the main cell types. Similar studies have been undertaken by Fischer, Canti and W. Lewis. Recently, the technique has been extremely simplified by certain mechanical devices invented by Rosenberger and by the fabrication of thin-walled flasks allowing the use of an immersion lens. When these flasks are employed, no special preparation of the tissues is necessary. The experiment to which the culture is subjected goes on without interruption while the microflask is placed in the apparatus and the behavior of the cells recorded as a routine procedure.

To summarize: Cytology, understood in the full meaning of the word, utilizes three groups of techniques: 1, ordinary chemical, physicochemical and physical techniques; 2, cytological and histological techniques; 3, physiological techniques that permit the isolation of pure strains of tissues and blood cells, and the study of the structural and functional characteristics of these cells while they live in media of known composition.

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It is with the help of this conception and of this method that a renovation of cytology and of histology has been attempted. This event is of recent date. The group of workers responsible for it is very small. The method has been used almost exclusively at the Rockefeller Institute and at the Kaiser Wilhelm Institute. So far, the studies have been confined to a limited number of cell types and to a few species of animals. Nevertheless, some fundamental properties of the tissues and of the internal environment have been discovered which classical histology completely ignored.

Tissue and blood cells are always in the process of becoming. They do not show their true physiognomy when they are examined under the microscope. Cinematography alone is capable of recording their fourth dimension. Fixed cells appear on the film as mobile as a flame. Their surface is never smooth. In some places, it bubbles like boiling water. Their body is composed of a fluid in which are suspended parts of a greater consistency, the nucleus and other organs. The nucleus, similar to an elastic ball, is surrounded by a belt of snake-like mitochondria which push it forward. Close to the nucleus and carried along with it by the cytoplasmic stream is a group of vesicles adherent to one another, resembling a bunch of grapes. They are the segregation apparatus of Renaut and the Golgi net. Through the anterior process, the cytoplasm seems to flow as a stream into the medium. Ameboid cells differ profoundly from fibroblasts and epithelium on account of the sharp definition of their surface and of their more rapid motion. The polymorphonuclear leucocytes are small and very agile amebas; the lymphocytes creep slowly like little worms; and the blood and tissue macrophages, which progress in an octopus-like manner, are surrounded by an almost invisible, undulating membrane. The folds of this membrane have the appearance of flagellate pseudopods.

Fixed and mobile cells, living outside of the body, always have a tendency to associate according to a pattern specific of the type. Fibroblasts organize in a matted tissue, where individual cells are in close but irregular contact. They never live as isolated units. A colony of fibroblasts looks like a dense crowd which moves without order. Very rarely do individuals wander far from the main group, which is composed of cells sliding upon one another in every direction. The colonies of epithelial cells associate in a more orderly manner. They can be compared to a regiment where each individual occupies an assigned place. Ameboid cells behave in quite a different way. They never form a tissue. They resemble a band of children scattering in every direction, with no other purpose than to run. While epithelial cells and fibroblasts aggregate in a tissue of limited dimensions, macrophages invade the entire medium at their disposal, as do bacteria. This tendency to retain a definite mode of colony formation persists in cells even after several years of life *in vitro*. However, the architecture of the colonies may be modified in some measure by the chemical composition of the medium. Under the influence of certain substances, macro-

phages form a matted tissue or assume the appearance of lymphocytes in a lymph node, or even flatten themselves like endothelium. Epithelial cells and fibroblasts may also wander away from the main colonies, as do macrophages. Nevertheless, their hereditary tendencies can always be recognized unless a change of the type itself has occurred.

Several important relations have been found to exist between the medium and the growth energy of a cell colony. First, the proliferative activity of a colony depends on the nature and the concentration of the substances contained in the pericellular fluid. Its resting condition is not due to its growth energy being kept under restraint by some unknown factor, but merely to the lack of proper food. Second, the substances that determine and support cell proliferation are chiefly embryonic proteins, plasma proteins and the larger split-products of certain proteins. Many other substances may stimulate cell proliferation without being able to support it. Third, in a given medium, each cell type shows a certain growth energy. This growth energy remains constant as long as the medium is not modified After nineteen years of life *in vitro* in embryonic juice, a strain of fibroblasts displays an unchanged rate of growth (Ebeling). Time has no effect upon a colony if the medium is constantly renewed. The aging of tissues results from the chemical changes which time imposes on the medium. A state of lower or higher growth energy can be produced at will by the introduction or the removal of proper substances in the pericellular fluid.

Tissues have the property of storing reserves when they live in a nutritive medium. The residual growth energy exhibited by a cell colony in a medium free from nitrogenous food expresses the presence of these reserves. The determination of its value has revealed marked differences in the aptitude of cell types to accumulate reserves at the expense of a given medium. This has led to the discovery of strains of fibroblasts which, although morphologically identical, differ in their nutritional properties. The food requirements of a given cell type are as fundamental a characteristic as its morphological aspect. It appears that each cell type demands a specific diet. Fibroblasts may multiply slowly in blood plasma (Fischer). They may also fail to multiply in such a medium, and ultimately die (Carrel, Ebeling). The explanation of this phenomenon is that fibroblasts, according to their origin, belong to different races characterized only by their food requirements (Parker). Some of these races proliferate slowly in plasma and remain for months in perfect condition, while others multiply still more slowly and degenerate very early. When embryonic juice and proteins, or hydrolysates of certain proteins, are placed in their medium, fibroblasts and epithelial cells always proliferate with great rapidity (Carrel, Ebeling, Baker). However, each type of fixed cells responds to these substances in its own way. The proliferation of fibroblasts in a given medium is always more rapid than that of epithelium. The food requirements of macrophages are quite different. These cells multiply very rapidly in blood plasma. They feed with great voracity upon fragments of fresh muscle or muscle killed by heat, protein precipitates, degenerated cells, etc. Substances such as embryonic juice, proteoses and peptones bring about their death at the concentration which is optimal for fibroblasts and epithelial cells. Nevertheless, at high dilutions, embryonic proteins and protein split-products cause a rapid proliferation of macrophages.

While the chemical conditions of the medium modify in this manner the growth energy of the colonies, they determine also important morphological changes. Two kinds of phenomena may occur: reversible changes in the form and dimensions of the cells and of their organs, or transformation of one cell type into another. Epithelium and fibroblasts, fed on embryonic juice, increase their volume. If proteoses are introduced into the medium, refractile granulations appear in the cytoplasm. The presence of serum produces large degeneration granules. Subjected to starvation in Tyrode solution, the cells and their organs decrease in size. Monocytes and macrophages are far more sensitive than fixed cells to the variations of the medium. A monocyte increases in size at least ten times when it is well fed. Pure plasma transforms macrophages into large cells surrounded by an undulating membrane and grouped like a thick undergrowth of bushes. The addition of amino peptones, sodium sulfide or enzymes from various organs, etc., may bring about the loss of the undulating membrane and the appearance of snake-like and fibroblastic forms, or the transformation of the mobile into mast-like cells. These changes are reversible. In a few days, the cells can be brought back to the state of macrophages with undulating membranes. When nitrogenous food is replaced by Tyrode solution, they grow smaller and revert to the dimensions of monocytes. Irreversible changes may be induced by certain media. During the digestion of their coagulum, macrophages that have been inoculated with extracts of Rous sarcoma transform into fibroblasts. Fibroblasts, treated with heparined plasma, may become macrophages. They acquire all the physiological properties of macrophages and remain indefinitely in that state.

The different cell types are also defined by the manner in which they modify their environment. Growth-promoting proteins, protein split-products, ferments, lactic acid, etc., may be detected in the

medium. Cell colonies growing in a semi-solid coagulum, where diffusion of the metabolites is slow, in some measure create their own environment. The medium adjacent to macrophages, thyroid or Ehrlich epithelium acquires new properties under the influence of the cell secretions. This indicates how various cell types act upon one another and contribute to the constitution of the local and general organic environments.

The isolation, in pure cultures, of a few strains of malignant cells has led to a simple method of investigating their nature. This method consists in comparing them with strains of normal cells of the same type from the point of view of their physiological and structural properties. At once the characteristics that cause malignant cells to differ from the normal ones become apparent. The macrophages of Rous sarcoma are diseased cells. They show many abnormalities, degenerate rapidly and are short lived. They possess the same food requirements as do normal macrophages, and their acid production is no greater. But they actively digest the fibrin of the coagulum, whereas this is not true of normal macrophages. The fibroblasts of sarcoma 10 of the Crocker Foundation, on the contrary, are healthy cells which never die. They resemble normal fibroblasts in their food requirements. But they differ from them because they digest the fibrin of the coagulum, produce more acid, and multiply rapidly in the presence of macrophages. The fibroblasts of Jensen sarcoma are also healthy cells. Although having food requirements similar to those of normal fibroblasts, they differ from them by their ability to multiply rapidly in blood serum and to digest the fibrin of the coagulum. The epithelial cells of Ehrlich carcinoma are diseased, like Rous macrophages, and very fragile. Even in pure cultures, they show structural irregularities, atypical mitoses, giant multinucleated cells, etc. They grow easily in rat serum, as do normal mammary gland cells. But unlike them, they invade fragments of embryonic tissue and digest the fibrin of the coagulum. The cells of the spontaneous mouse cancers differ in their properties from both normal and Ehrlich epitheliums. They liquefy fibrin and produce more acid than normal cells do. But they are generally deprived of the power to attack embryonic tissue and to feed upon it. Thus, it appears that the malignant types, which differ from one another in some aspects, have certain properties in common. They digest fibrin and feed upon substances or tissues which are not utilized to the same extent by normal cells. We may assume that *in vivo* they are malignant because they have the power of manufacturing from the neighboring tissues or interstitial lymph the nutrient substances which promote their unlimited proliferation. An important fact is thus brought to light: the mutability of certain cell types. Malignant cells are variants of the normal type. They differ slightly from it in some of their properties. These differences are not qualitative, but only quantitative. They are persistent. The cells do not revert to the original type even after years of cultivation *in vitro*. They are fixed variants, possibly analogous to those arising in microbic dissociation under the influence of several chemical substances and of the lytic principle of Twort.

The internal environment, which allows cells and tissues to manifest their life *in vivo*, consists of blood plasma, lymph and several varieties of interstitial fluids. While many of the chemical, physicochemical and physical conditions of blood plasma have been ascertained, especially through the studies of Van Slyke, Henderson, Haldane, du Noüy and others, the effect of these conditions on the main cellular types has not been investigated. In other words, the response of tissues to the organic medium and its constituents has remained almost entirely mysterious. Although we are still very far from knowing how this medium determines the functional activities and the differentiation of the main cell types, we have, however, brought to light some of its properties. Blood plasma supplies tissues with the substances they require for their growth. But it is not utilized in the same manner by the different cell types. Macrophages, as is well known, multiply actively in pure plasma, while epithelial cells and fibroblasts proliferate very slowly or not at all. Besides this nutrient effect, plasma possesses the characteristic of inhibiting the growth of connective tissue and epithelium. This property appears early in life, and increases rapidly with age in young animals, and more slowly in old animals. At the end of life, the inhibiting power of blood plasma is very marked. This growth-restraining property is due to the proteins and chiefly to the lipoids that it contains (Carrel, Ebeling, Baker). In certain pathological conditions, such as local infection, cachexia, etc., blood plasma also becomes inhibiting. It is probable that variations in the growth energy of tissues in function of age, as evidenced by the rate of cicatrization of a wound (du Noüy), or the residual growth energy of tissue (Carrel), can be attributed to such modifications of blood plasma. This growth-restraining effect can be partly counterbalanced, even in extreme old age, by embryonic proteins, protein split-products and leucocytic secretions. Therefore, a resumption of the proliferation of fixed cells is always possible *in vivo*. The cicatrization of a wound or the growth of a tumor occurs even in senile individuals. This inhibiting effect of plasma seems to be connected in some manner with cell differentiation. A pure strain of iris cells, treated with blood serum, decreases its rate of multiplication and manufactures large quantities

of black pigment. Important as these facts are, our knowledge of the internal environment is still in its infancy. The conditions of local organic media, that is, of the interstitial fluids of the tissues, have not as yet been discovered. We can assume that they resemble those of plasma, although modified by the products of cell activities. Each tissue or organ certainly manufactures in some measure its own medium, which, in its turn, acts on the cells. It is only through the analysis of the physicochemical and chemical conditions of the local medium that the state of a tissue *in vivo* can be completely understood.

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The success of the new method in bringing about the discovery of so many phenomena must be attributed to its power, which histology, physics and chemistry lack, to apprehend the complex system formed by the tissues and their environment. The concepts and methods of physics and chemistry are adapted to the atomic and molecular levels of the organization of matter. When applied to the cellular and supracellular levels, they detect only phenomena of the atomic and molecular orders. On the other hand, cytology and histology are concerned exclusively with the form of cellular and supracellular organisms. Therefore none of these sciences alone is capable of dealing with physiological phenomena, such as organization and adaptation, which belong to the supracellular order and are the expression of sociological laws. The laws specific of physiology, said Claude Bernard, are the laws of organization. Such are precisely the phenomena and the laws that the new cytology endeavors to discover by coordinating, through its own techniques, the data supplied about cells, tissues and organic fluids by physics, physical chemistry, chemistry and classical cytology and histology. Studied in this manner, cells and tissues appear as being endowed with properties which make them not only the building stones, but also the builders of an organism capable of developing, maturing, growing old, repairing wounds and resisting or succumbing to diseases. It is with such an aspect of the tissues that embryology and pathology, as well as cytology, should be concerned.

Experimental embryology, which searches for the mechanisms of the determination and differentiation of structures, may never completely fulfil its purpose unless its conception of cells and tissues, and its techniques, are modified. If embryonic parts were transplanted into media of known composition, instead of being grafted on a living body, it would be possible to ascertain how far development is dependent upon properties inherent in the cells themselves, and in what manner it is determined by the conditions of the pericellular fluid. Conversely, the transplantation of cell colonies into different parts of the body of the living embryo would reveal how the local internal environment may modify each cell type.

Although descriptions of the changes produced in cells and tissues by pathogenic factors fill many books, the mechanism and the significance of these changes remain practically unknown. This shortcoming must be attributed to the fact that cellular pathology, like histology, is based on an incomplete conception of the nature of tissues. The adaptation of the body to diseased conditions can not be understood as long as cells are conceived to be mere structural units. However, by taking into consideration the physiological properties of tissues as manifested under the influence of bacterial and other chemical changes in the organic medium, the doctrine of Virchow could be rejuvenated and extended to the whole field of pathology.

In the development of the new cytology, as in the development of every science, the conception is more important than the method. Techniques are only the servants of ideas. They have no great power in themselves. For this reason, the application to biological problems of the so called method of tissue culture by workers still clinging to classical cytology and histology has led to the confirmation of facts already known, but not to any real discoveries. A method is an instrument which finds only that which is being sought. The new cytology is considering cells and tissues, not only as elements of the dead body, but as living beings which are themselves parts of organisms of a more complex order. With the help of the auxiliary sciences of physiology, it is progressively discovering the properties which make these cells and tissues the structural and functional units of an harmonious whole.

THE ADVANCEMENT OF HORTICULTURAL RESEARCH[1]

By Professor A. T. ERWIN

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HORTICULTURE is both a science and an art. Its applications as an art long preceded its development as a science. The hardening off of plants was practiced for years before the notable studies of Whitten, Rosa and others dealing with sap densities, etc., were made. Chandler rather uniquely expresses the situa-

[1] Presidential address before the American Society of Horticultural Science.

tion thus: "It is probable that, more often than otherwise, when a discovery is made that explains in a fundamental way some response of the tree, we shall look, not forward to its application, but backward to find it already in practice." That research in horticulture should catch up, so to speak, and take a position in the advance guard and open the way for new applications goes without saying. May I offer two or three suggestions which, it seems to me, might in some measure contribute to this end.

Obviously, there can be no research without a researcher. The content of horticultural courses, and the training of research workers in this field, is a subject within itself. However, in passing I would like to raise this inquiry: As horticulturists, should we not lay greater emphasis upon the necessity of building up an adequate background and the development of a perspective, as the first step in an investigation? The acquirement of skill in searching out the literature of horticulture and related sciences as a means to this end is obviously a necessary corollary. A survey among employers of chemists brought forth the criticism that college graduates do not know how to use a library. Perhaps the criticism might have gone one step further and raised the question as to whether a college training develops within the student the inclination and incentive to use the library. Does the average student leave the campus with the feeling that he has completed his education or with the realization that it has only begun? I am beginning to wonder if we have not all sinned more or less in digesting material for the student (I refer to upper classmen and graduates) instead of requiring them to ferret it out for themselves and thus acquire the library habit. It was Bishop who said, "It is only by a combination of the historical and the experimental method that any work of first-rate importance can be produced in any field of knowledge."

Progress in any field of science is dependent upon the new worker beginning where the last one left off. "Failure to build upon the past," says Dr. True, "frequently means aimless wandering about in fields previously explored. The preparation of a bibliography at the beginning of a new project affords a knowledge of the field and also serves as a guide to the possibilities of further research."

The growth of research work, in the various fields of plant investigation, has been so great that a literary survey is sure to bring the worker in touch with new sources of information and new angles of approach to his particular problem. Crane says, "Literature is the foundation of every scientific inquiry of importance." A prominent manufacturing firm expended one thousand dollars on a certain experiment. A satisfactory product was obtained, upon which they applied for a patent. Much to their pain and surprise they learned that this particular field had already been rather completely explored and that a number of patents had been granted previously. Probably few station workers know anything about such generous allotment of funds for a single project, yet the incident does enforce the need of a complete survey of the literature of a particular field before proceeding with the investigational work in the laboratory. Some one has said that every monkey has to start his investigations where his father did; consequently, there is no advance of knowledge in monkeydom.

This subject has another important aspect. There is a serious need for more direct means of access to the literature of horticulture. From the various state experiment stations and related organizations there is an enormous volume of material, much of which is accessible to the research worker only at the expense of an endless amount of time and energy. Considerable progress has been made in the way of providing working tools for access to the literature, such as reviews, digests and indices, and yet an impartial survey of the field will, I believe, bring forth the verdict that the literature of agriculture is inadequately equipped with these facilities as compared with the field of engineering, for example, and that we are lagging behind in this respect.

The *Experiment Station Record* provides well-written digests of station publications. The reviews affecting horticultural crops, however, are spread among the editorial departments of agricultural botany, field crops, horticulture, genetics, soils, and fertilizers and entomology. Since the same subject is handled in different departments in different institutions, the identical subject-matter may be reviewed in any one of the above-named editorial departments. As a consequence there is no definite guide as to where to turn for the information desired, and the result is that it is necessary to review the literature of all of these departments for a given topic. From the view-point of a crops specialist a topical classification in the *Experiment Station Record* would have many advantages. Under this arrangement all of the reviews relating to apples, for example, would be classified under that crop as the unit. Possibly the specialist in other than crop fields would prefer the present arrangement. It would seem that a topical and authors' index to each number would solve the problem. Since this has to be done anyway at the end of the year, it would mean only a slight expense to provide a cumulative index with each number as is done with the Agricultural Index, for example.

The Cumulative Indices of the *Experiment Station Record* is a valuable source of reference. The last

number, however, was issued in 1919; consequently it is eleven years behind.

Agricultural Index covers a comprehensive digest of a selected list of agricultural periodicals and bulletins from 1916 to date, and the indices are cumulative by quarters. Many of the articles reviewed are popular in character and this publication serves the general reader rather than the research worker.

The U. S. Department of Agriculture published a topical card index of the literature of the experiment stations and kindred institutions. This was discontinued in 1916, so that it is now fourteen years out of date; it also lacks an authors' index.

The U. S. Department of Agriculture also maintains a card index of the publications of the federal department which is complete and up-to-date, both as to subjects and author. The federal department also publishes at intervals a list of bulletins of experiment stations.

Biographical Abstracts is an invaluable source of information but contains no indices for any of its volumes.[2]

In contrast with this situation, in the field of engineering and chemical literature we find available a complete card catalog both as to author and subject and with numerous cross references. Some one has said that the card catalog is the master key to a library. The point I am trying to make is that there is a vast field of agricultural literature for which this key is lacking, and the situation is one which seriously retards horticultural research. The card catalog of experiment station literature referred to above would serve as an excellent nucleus for such a program but is too far out of date to be more than a starting point, as it is. In some fields, as genetics for example, most important concepts have been presented during the past decade.

I am sure that we can all testify to the fact that librarians as a class are ambitious to serve every field of science, including agriculture, and stand ready to cooperate with other departments, but with limited funds they naturally respond to the calls from the fields where there seems to be the greatest interest, so perhaps one way of remedying this situation is for us as horticulturists to get behind a library program and make it a more significant factor in our teaching and research work. The interest and support of the department heads in behalf of more adequate appropriations for library work would, no doubt, also help.

The particular problem of classifying and making accessible, through a card catalog, the vast body of experiment station literature is obviously an appropriate federal activity and probably hinges on the matter of funds. If so, the members of this society might here lend a helping hand. Aside from the experiment station literature, the proceedings of this society affords a most important source of information. A complete card index by title and author of its proceedings would be of great value to every state college library. Completion of the card catalogue, dropped by the federal department fourteen years ago, might well include this class of literature. A card catalogue of experiment station literature similar in character that is now available for the publications of the U. S. D. A. would prove valuable to station workers. The federal government has invested large sums in these investigations and a modest sum to make the reports of these results accessible would surely be a logical program.

May I now turn from the matter of library facilities to the subject of research projects. The accumulation of reliable data on field crops requires both a consecutive effort toward a definite objective and a considerable period of time for its execution. The objective remains the same from year to year, but the method of procedure may require revision. I need only mention the modern concepts of sweet corn breeding, as compared with the ear to row method of a decade ago, as an example. Without any thought of hastening a project to a premature conclusion, a complete and thorough review of all station projects by a capable, broad-minded committee, in conference with the chief and project leader may prove very helpful. Such a review made in a critical yet sympathetic spirit may bring to the leader new avenues of approach to his problem and liberate him from some conventional methods to which he has become wedded. Such a project review may also bring to light unproductive activities, the continuance of which means only a waste of time and money.

This review is also apt to result in a revision of project outlines. With a refinement of methods the very term, project, has taken on a new meaning. This new view-point is concisely expressed in an address by Dean R. E. Buchanan before the Association of Land Grant Colleges, from which I quote: "The ultimate division of research, the particular thing upon which the member of the staff is working, we call a project. Related projects may be grouped into larger units called a program. Related programs may be grouped into a field." The trend is therefore definitely in the direction of projects, being more concrete with a more direct approach, a more clearly specified goal and a title as informative and explicit as possible. This results in the elimination of certain factors and simplifies the interpretation of the resulting data. With a more limited objective and a more direct attack the project will probably be less protracted, though I do not think this should be the point of emphasis. A review of experiment station

[2] The Index to Volume 1 has appeared since this was written.

literature along most any crops line will, I believe, justify the assertion that more sins have been committed from premature publication than from overconservatism in this regard.

A review of activities in the light of the term project, as above defined, may also lead to the conclusion that many of our listed projects are in reality programs, any one of which being divided into its component and restated means several projects. To cite an example in our own institution, sweet corn breeding is one of the major projects of the Vegetable Crops Section. The first step is, of course, the development of homozygous lines, and second, that of crossing. As restated we now have two projects; one, the development of homozygous lines of specified varieties of sweet corn, and the second the crossing of these lines for certain specified objectives.

The growth of the extension movement is probably the outstanding characteristic of our agricultural history of the past quarter of a century. It carries to the great body of farmers the results of the experiment station and is an activity of inestimable value. It has, however, greatly stimulated inquiry on the part of the grower, and as a result many station workers are deluged with a large volume of inquiries, which makes a heavy drain of both time and money upon the field of research for an activity which is clearly not research in character. Every institution should welcome the opportunity to serve in this way, but the service belongs to the field of extension rather than research. There is need of the heartiest cooperation between the extension worker and the station staff in answering certain inquiries of a technical character. There are also instances where it is an advantage for the station worker to keep in touch with his constituency in some particular territory where he is dealing directly with a project, the outcome of which is of interest to both the grower and the station. To the extension service also belongs the miscellaneous testing of seeds and other work of a similar character; a useful service, but not a research activity.

As a closing sentiment may I quote, "The spirit of research is Devotion to Truth and an insistent Longing for Better Understanding." In that spirit, let us press forward and meet the challenge of the new year.

SCIENTIFIC EVENTS

INTERNATIONAL MEETINGS IN ENGLAND[1]

THE jubilee celebrations of the Society of Chemical Industry, it has been announced, will be of a domestic character, the functions being thrown open only to members and a very few distinguished guests who will be the recipients of special honors. The society was founded in 1881, and to-day has upwards of 7,000 members, associate members and subscribers. The meetings will commence on July 13 and will extend over the succeeding seven days. It is hoped the Lord Mayor of London will open the proceedings by receiving the delegates at the Guildhall, and succeeding events will include the annual dinner, the annual general meeting, the delivery of the presidential address, and the presentation of the society's medal. Visits to many works typical of the manufactures of London are being arranged; the Chemical Engineering Group of the society is arranging an exhibit of special recording and measuring instruments in the Central Hall, Westminster, where there will also be an exhibit of British chemical plants arranged by the British Chemical Plant Manufacturers' Association. To mark the occasion permanently, Dr. Stephen Miall, editor of *Chemistry and Industry,* is writing a history of the chemical industry, to be published at a low cost immediately prior to the meeting, and a special jubilee number of the *Journal* of the society will be published containing reprints of outstanding papers, biographies of presidents, medallists and honorary members, and a history of the society. While the preliminary program was being arranged, the late Lord Melchett held the presidency of the society, but he has now been succeeded by Sir Harry McGowan. The headquarters of the society are at Central House, 46 Finsbury Square, E.C.2, Mr. H. J. Pooley being the general secretary.

The meeting of the International Illumination Congress, the ninth of its kind, will be divided into two parts, the first part consisting of a congress which will be held from September 2 to 12, and the second part consisting of meetings of the technical committees of the International Commission on Illumination, to be held from September 13 to 19. The congress, of which Mr. C. C. Paterson is the president, is being organized by the National Illumination Committee of Great Britain, in cooperation with the Illuminating Engineering Society, 32 Victoria Street, S.W.1, Colonel C. H. S. Evans being the honorary general secretary. After assembling in London on September 1 to 3, the delegates will then spend two days at Glasgow, three days at Edinburgh, two at Sheffield, two at Birmingham, and the remainder of the time, from September 13 to 19, at Cambridge. At the latter place will be held the plenary session of the International Commission on Illumination. A comprehensive list of subjects for discussion has been drawn up, and papers will be presented on the lighting of factories, offices,

[1] From *Nature.*

houses, vehicles, streets, museums and lighting for traffic control, together with others on lighting for aviation and navigation, flood lighting, architectural lighting, laboratory technique and the lighting of mines. Many institutions are represented in the general council of the congress, the chairman of which is Lieutenant-Colonel K. Edgcumbe. The first three International Illumination Congresses were held at Zurich, and the others have since been held at Berlin, Paris, Geneva, Bellagio and Saranac, New York.

THE FIFTEENTH INTERNATIONAL CONGRESS OF AGRICULTURE

WORLD agricultural policies with a view to organizing agricultural production in different countries so as to equalize the supply with the demand for farm products will be considered at the fifteenth International Congress of Agriculture at Prague, which meets from June 5 to 8. Ninety-two national agricultural associations from twenty-seven countries will participate in this congress to be held under the auspices of the International Commission of Agriculture.

Professor Dr. Ing. Vlad. Brdlik, president of the organization committee, has asked the U. S. Department of Agriculture to bring the congress to the attention of agricultural scientists and leaders in this country. The department has acquiesced in this request and suggests that American agriculturalists who may be traveling in Europe at the time of the congress will find it to their advantage to include Prague in their itineraries. The congresses are held every two years in different countries, under the auspices of the governments of the countries in which they are held.

The program this year is separated into seven sections entitled agrarian policies and rural economy; agricultural education and extension; agricultural cooperation; vegetable production; animal production; agricultural industries, and "the rural woman."

The section on agrarian policies and rural economy will consider the possibilities of organizing agricultural production in different countries with a view to bringing about an equilibrium between supply and demand of agricultural products, and in what measure and by what means the expenses of production may be decreased. The importance and possibility of research on the formation and forecasting of agricultural prices will also be considered.

The section on agricultural education and extension will consider services of agricultural consultations on an individual basis; methods employed and results obtained, and modern methods for promoting progress in rural districts by means of radio, motion pictures, agricultural expositions and other agencies for making known the results of research. The section on agricultural cooperation will consider education in cooperation, the means employed and results obtained. The section on vegetable production will consider national and international legal protection of new plant production and the actual status of the question of inoculating the soil.

The section on animal production will consider heredity and its control in individual animals in order to improve their economic yield, and the possibilities of raising fur-bearing animals in connection with farming. The section on agricultural industries will consider methods and importance of the industrial utilization and conservation of potatoes and other vegetables. The mission of the woman in the struggle against the rural exodus will be the principal topic of the section on the rural woman. The feeding of the farm family by means of products grown on the farm will also be considered by this section.

THE PASADENA MEETING

PLANS for the Pasadena meeting are now well under way. The main features follow rather closely the precedent set by the British Association for the Advancement of Science. These are (1) meetings extending through a full week, June 15–20, (2) emphasis on symposia, (3) scientific sessions in the morning only, (4) afternoons devoted entirely to opportunities for discussion and personal contact through large numbers of excursions, and (5) popular addresses each evening by speakers of national and international reputation.

Professor Thomas Hunt Morgan, retiring president, and Professor Franz Boas, newly elected president of the association, both expect to attend the meeting.

Astronomy (Section D) will be well represented in the program, since the Astronomical Society of the Pacific, a very strong affiliated society, will meet with the association at Pasadena. Tentative plans call for three morning sessions, and a fourth if the number of papers requires it. One of these sessions will be devoted to invited papers on "Problems of the Two-Hundred-Inch Telescope" and "The Physical Interpretation of Stellar Spectra." A list of other societies which will meet with the association is given in SCIENCE for February 27.

Dr. Hale's spectrohelioscope will be available for the actual use of visitors, the treasures of the Huntington Library and Art Gallery will be shown, Kennedy's repetition of the Michelson-Morley experiment, the 100-inch telescope, the 1,000,000-volt laboratory and its giant x-ray tube, will all probably be available.

Special round-trip rates will be offered by the railways. For example, the round-trip rate (out and back over different lines) from New York will be approximately $140, from Chicago $90.

CHARLES F. ROOS,
Permanent Secretary

FELLOWSHIP IN MEMORY OF JAY BACKUS WOODWORTH

A JAY BACKUS WOODWORTH graduate fellowship in geology has been completed to a total of $25,009.98, by contributions from 85 persons, mostly former students of Professor Woodworth at Harvard. The committee consisted of Richard M. Field, Edward Mallinckrodt, Jr., Charles Palache, Thorndike Saville, R. W. Sayles, T. Wayland Vaughan, Robert DeC. Ward, Edward Wigglesworth and Charles F. Brooks, *chairman*.

It is the hope of the committee that the first award of this fellowship may be made for the coming academic year, even though the accumulated income by that date will not equal the full amount to be expected in later years.

The fellowship is in memory of Jay Backus Woodworth, distinguished Harvard seismologist, who died in 1925. Owing to Professor Woodworth's broad interest in the whole field of geology, the award of this fellowship is not to be restricted to any one phase of the science.

In the letter of gift to President Lowell, the committee expressed preference to have this fund used according to the following conditions:

> On the recommendation of the division of geology of Harvard University, or of such other body as may succeed to the functions of this division, the income of this fund is to be appropriated from time to time as a graduate fellowship in geology, preference being given to a candidate who has shown decided capacity in the pursuit of geology and good promise of advancing the science. However, if future conditions should be such that the foregoing directions can not be followed to advantage, the disposal of the income shall, by vote of the division of geology, or of such other body or bodies as may succeed to the functions of this division, with the approval of the corporation, be otherwise made in the interests of geological research or higher training in geology.

AWARD OF THE LEIDY MEDAL OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA

THE Academy of Natural Sciences of Philadelphia announces the selection of Dr. William Morton Wheeler, professor of entomology at Harvard University and dean of the Bussey Institution for Applied Biology, as the recipient of the third Joseph Leidy Memorial Award. Dr. Wheeler was selected "in recognition of his comprehensive and exhaustive studies of the ants of the world, their structure, classification, social organization and behavior; his equally noteworthy contributions to our knowledge of animal psychology, and analyses of evolutionary processes."

The Joseph Leidy Memorial Award was founded in 1923, and consists of a bronze medal and honorarium, given every third year, "as a reward for the best publication, exploration, discovery or research in the natural sciences in such particular branches thereof as may be designated." The selection of the recipient of the award is placed in the hands of a committee of the academy, which body also determines the fields of activity to be considered.

The first award of the Leidy Medal was made in 1925 to Dr. Herbert Spencer Jennings, of the Johns Hopkins University, for his researches upon the Protozoa and the Rotatoria. The second award, in 1928, was made to Dr. Henry A. Pilsbry, curator of mollusks of the Academy of Natural Sciences of Philadelphia, in recognition of his researches upon the phylogeny of the terrestrial mollusca, and his work on the classification of the Cirripedia.

The committee on the Joseph Leidy Award for 1931 was composed of Dr. Witmer Stone, chairman, Mr. Childs Frick, Dr. Thomas Barbour, Dr. Herbert Spencer Jennings and Mr. James A. G. Rehn.

The award will be formally presented to Dr. Wheeler at the meeting of the academy to be held on April 21.

SCIENTIFIC NOTES AND NEWS

ON the occasion of the commemoration of the one hundred and fiftieth anniversary of the Manchester Literary and Philosophical Society on March 17, Sir J. J. Thomson made the address and the Dalton Medal was presented to him.

PRESIDING at the convocation of Calcutta University, Sir Stanley Jackson, the governor of Bengal, presented the Hughes Medal of the Royal Society to Sir C. V. Raman, who was recently awarded the Nobel Prize in physics.

THE Bessemer Gold Medal of the British Iron and Steel Institute has been awarded this year to Sir Harold Carpenter, professor of metallurgy in the Royal School of Mines, Imperial College of Science and Technology, London, in recognition of distinguished services in the advancement of metallurgical science.

DR. JOHN ALEXANDER LOW WADDELL, consulting engineer of New York City, was presented with the first award of the Clausen Gold Medal, "for distinguished service to the engineering profession in the field of welfare," at a dinner of the American Association of Engineers on March 12. Mr. James H. Griffin, president of the association, made the presen-

tation. Dr. David B. Steinman, consulting engineer, served as toastmaster. Other speakers included G. M. Butler, dean of the College of Mines and Engineering of the University of Arizona, and Francis H. Sisson, vice-president of the Guaranty Trust Company.

DR. ROY CHAPMAN ANDREWS, of the American Museum of Natural History, was on March 13 awarded the Hubbard Gold Medal by the National Geographic Society for his geographical discoveries in Central Asia. Dr. Andrews, who discovered fossils of nearly a hundred species of prehistoric animals in the Gobi desert, will be the ninth man to receive the medal, the highest honor the society bestows. The medal was presented by Dr. Gilbert Grosvenor, president of the society.

CAPTAIN SIR GEORGE HUBERT WILKINS, who took the remodeled navy submarine *0–12* on its trial run on March 16, in preparation for his underseas Polar trip, received the Elisha Kent Kane Medal from the Geographical Society of Philadelphia on March 11 for "outstanding achievement in exploration." The medal was awarded at the society's annual dinner. Sir Hubert was the principal speaker. Dr. Roy Chapman Andrews was the recipient of the medal two years ago, and Rear Admiral Richard E. Byrd received it in 1927.

THE *Journal* of the American Medical Association reports that Dr. John Chalmers Da Costa, Samuel D. Gross professor of surgery, Jefferson Medical College, delivered a lecture reviewing his forty years' active work in surgery as the principal feature of the first observance of Da Costa Day by the Philadelphia County Medical Society on March 11. There was an attendance of over one thousand. Da Costa Day was inaugurated last year with the establishment of the John Chalmers Da Costa Foundation for the purpose of furthering postgraduate teaching under the auspices of the society.

DR. GEORGE W. CRILE, head of the Cleveland Clinic and professor emeritus of surgery at Western Reserve University School of Medicine, was the guest of honor at a dinner given by about 400 physicians on February 23. Dr. Charles H. Mayo was the principal speaker.

DR. WALTER LAWRENCE BIERRING, Des Moines, for many years secretary of the Federation of Medical Boards of the United States, was the guest of honor at a dinner given by the Des Moines Medical Library Club on March 7.

THE William H. Nichols Medal of the New York section of the American Chemical Society for 1931 was presented on March 13 at the Engineering Societies Building to Dr. John Arthur Wilson, of Milwaukee, "for outstanding achievement in colloid chemistry, applied particularly to leather and sanitation." The presentation was made by Dr. J. G. Davidson, of the Carbide and Carbon Chemicals Corporation, chairman of the jury of award and past president of the New York section. D. P. Morgan, Jr., secretary of the section, read an address by Dr. Clarke E. Davis, production manager of the National Biscuit Company, on the life of the medalist, and Professor Arthur W. Thomas, of Columbia University, spoke on the recipient's scientific accomplishments. Professor Arthur E. Hill, of New York University, chairman of the section, presided. Dr. Wilson responded with an address on "Leather, Sanitation and Colloid Chemistry."

AT the annual meeting of the American Society of Naturalists in Cleveland, Dr. J. Playfair McMurrich, professor of anatomy at the University of Toronto, was elected an honorary member of the society. The American Society of Naturalists was founded in 1883, and Dr. McMurrich has been a member since 1884. He was president at the Chicago meeting in 1907 and has served the society from time to time in various other capacities.

THE title of "professor emeritus" has been conferred upon Dr. Walter Ramsden, who resigned from the Johnstone chair of biochemistry at the University of Liverpool last December.

DR. HOWARD MCCLENAHAN, secretary of the Franklin Institute, Philadelphia, has been elected to the council of the American Association of Museums. Dr. McClenahan fills the vacancy created by the resignation of Mr. Waldemar Kaempffert, who is leaving the directorship of the Museum of Science and Industry at Chicago to become a member of the staff of the New York *Times*.

DR. LOUIS I. HARRIS, who resigned as health commissioner of New York City to become health expert for the National Dairy Products Corporation, has dissociated himself from the latter corporation.

AFTER serving for more than ten years as secretary-treasurer of the New York State Forestry Association, James R. Simmons resigned his position on March 5. John C. Sammi, instructor in the department of engineering at the New York State College of Forestry, has been appointed temporarily to fill the office vacated by Mr. Simmons.

DR. J. ROSSLYN EARP, lecturer in the University of Colorado, has been appointed director of the bureau of public welfare of New Mexico, succeeding Dr. George Sparr Luckett, who resigned several months ago.

MR. HAROLD J. COOK, curator of paleontology in the Colorado Museum of Natural History, Denver, is resigning from the active staff of the museum to give full time to private affairs and to the active development of the Cook Museum of Natural History at Agate, Nebraska.

CAPTAIN W. P. B. BEAL, formerly principal veterinary officer of the Gold Coast, has been appointed superintendent of the new zoological park of the Zoological Society of London at Whipsnade. It is expected that the park will be opened this spring.

DR. WILLIAM W. CORT, professor of helminthology in the Johns Hopkins Medical School, and Dr. George E. Nichols, professor of botany and director of the Marsh Botanical Garden of Yale University, will during the coming summer be members of the staff of the Douglas Lake Biological Station of the University of Michigan.

PROFESSOR HENRY B. BIGELOW, of Harvard University, scientific adviser to the International Ice Patrol, sailed on March 11 for Copenhagen to attend the conference of the International Council for the Exploration of the Sea, to be held from March 23 to 30.

DR. ALBERT W. HERRE, curator of the zoological museum of Stanford University, left on March 9 for an extended collecting tour among the islands about the Sulu and Celebes Seas. From Mindanao and Borneo he plans to go to Canton, China, to collect fishes in that region.

DR. J. HENDERSON SMITH, in charge of the plant virus disease research at the Rothamsted Experimental Station, Harpenden, England, is at present making an extended tour of the botanical institutions of America in relation to his investigations in plant pathology. On March 9 he gave an illustrated lecture with motion pictures on "Intracellular Inclusions in Plant Virus Diseases" before the department of botany of Columbia University, under the auspices of the Institute of Arts and Sciences of that institution.

PROFESSOR RICHARD COURANT, of the University of Göttingen, will join the faculty of the University of California at Berkeley for the summer session of 1932. Professor Paul S. Epstein, of the California Institute of Technology, Pasadena, will arrange for lectures at other institutions by Professor Courant during the spring of 1932.

DR. DONALD H. ANDREWS, of the department of chemistry of the Johns Hopkins University, recently gave a series of three lectures at the University of Minnesota on: "Seeing Inside the Molecule"; "Thermal Energy in Organic Molecules," and "The Leiden Low Temperature Laboratory."

THE annual meeting of the Illinois State Academy of Science will be held in Peoria on May 8 and 9 under the presidency of Dr. Fred R. Jelliff. The general program of the forenoon of May 8 will consist of addresses by Dr. William Hoskins, of Chicago; Dr. T. R. Hogness, of the University of Chicago, and Dr. A. C. Ivy, of Northwestern University, on various phases of chemical development, while the addresses that evening will be by President H. W. Chase, of the University of Illinois, and by Dr. Francis G. Blair, state superintendent of public instruction. The afternoon of the eighth will be devoted to sectional meetings. On Friday the Junior State Academy will also meet and will have its own program. Saturday will be largely given over to field trips.

THE Kansas Academy of Science will hold its sixty-third annual meeting at the University of Kansas on April 24 and 25. General papers and business will occupy the forenoons while the afternoons will be devoted to sectional programs in biology, entomology, physics, chemistry and psychology. A banquet will be held in the evening of April 24 and will be followed by the address of the president, Dr. Hazel E. Branch, of the University of Wichita. Later in the evening there will be a public address. Scientific men of neighboring states are cordially invited to attend the sessions of the academy and may appear on the program if they will send their titles of papers to the secretary, Dr. George E. Johnson, at the Kansas State Agricultural College, Manhattan, Kansas.

THE monthly meeting of the Torrey Botanical Society of America, held on March 3 at the department of botany of Columbia University, was devoted to demonstrations and methods of biological teaching in high schools and undergraduate colleges. More than a hundred exhibits and demonstrations ranging from elementary biology, mycology, medical and plant pathology, morphology and physiology illustrating favorable materials and methods for teaching had been set up for the occasion. This meeting also marked the official opening of the new quarters of the department of botany at Columbia University.

THE fourth annual meeting of the Texas Entomological Society was held on March 9 in San Antonio, Texas. This organization is unique in that it is composed of seventy-five members, each one of which holds either a federal or state entomological position. A very full program was given consisting of papers reporting upon original research or progress made on field control of economic insects. Resolutions were passed supporting the bill for a state museum now before the legislature; providing for a committee to formulate a bill providing for laws regulating the

sale of insecticides, vermifuges and fungicides, and to provide for licensing firms attempting to put on campaigns against insects. Action was taken completing the affiliation of the Texas Entomological Society with the Texas Academy of Science. A committee was provided to plan for the erecting of a memorial to Belfrage, the pioneer Texas entomologist. S. W. Bilsing, M. A. Stewart and F. L. Thomas were reelected as president, secretary-treasurer and vice-president. A feature of the program was a visit to the U. S. Pink Boll Worm Laboratory, where Mr. R. E. McDonald, who is in charge of this work, conducted the party through the laboratory and explained the work of the collection of something more than a million cans of cotton bolls from all districts of the United States and of their subsequent examination for the pink boll worm.

THE American Public Health Association announces that its sixtieth annual meeting will be held in Montreal from September 14 to 17, with the Windsor Hotel as headquarters. The association has not held a meeting in Canada since 1908 and public health workers from the Dominion and from the United States are invited to take advantage of this opportunity for closer contact. The program is being planned with the progress and needs of both countries in mind. Such subjects as toxoid immunization; rural sanitation, particularly the organization of a practical program for county health units; health education for a large city, for a small city, and for a rural community; camp and resort sanitation, including fungus skin infections, particularly those transmitted in swimming pools, and general sanitation of auto camps, have been considered so important by the program committee that special sessions will be devoted to them. Each section of the association will arrange individual programs, covering public health administration, laboratory research, vital statistics, public health engineering, food, drugs and nutrition, child hygiene, public health nursing, health education, epidemiology and industrial hygiene. Meetings of four other organizations, the American Association of School Physicians, the Conference of State Sanitary Engineers, the International Society of Medical Officers of Health, and the International Association of Dairy and Milk Inspectors—will take place during or immediately preceding the sessions of the association. For further information address the American Public Health Association, 450 Seventh Avenue, New York, N. Y.

THE California Academy of Sciences announces a special course of four free public lectures on the general subject, "The Beauties of Nature and the Forces Which Have Had to Do with Making This World the Interesting and Beautiful World That It Is." The lectures, which will be given on the evenings of April 1, 8, 15 and 22, are: "The Growth of the Earth as an Abode of Land Life," by Dr. Bailey Willis, professor emeritus of geology, Stanford University. "The Age of the Earth as Taught by the Grand Canyon of the Colorado," by Dr. William Morris Davis, professor emeritus of geology, Harvard University. "The Origin and Development of Land Plants," by Dr. Douglas Houghton Campbell, professor emeritus of botany, Stanford University. "The Origin, Distribution and History of the Giant Sequoias, the Oldest Living Things in the World," by Dr. Willis Linn Jepson, professor of botany, University of California.

THE Second International Congress of Linguists will meet at Geneva From August 25 to 29, 1931. The first congress was held from April 10 to 15, 1928, at La Haye. Those interested in the congress should communicate with M. Albert Sechehaye, Rue de l'Université 5, Geneva, Switzerland.

THE American School of Prehistoric Research, jointly with the British School of Archeology at Jerusalem, will begin on April 1 excavations at the foot of Mount Carmel, near Athlit, Palestine. Work will be carried on simultaneously at two caves in the Wady el Mughara and at another site near by. Miss Dorothy Garrod, of the British School, will be in charge. The eleventh annual summer session of the American School of Prehistoric Research will open in London on July 1. Dr. V. J. Fewkes, of the University of Pennsylvania, will be in charge. The itinerary includes London, East Anglia, Paris, Brittany, Charente, Dordogne, the Pyrenees, Lyons, Neuchâtel, Zurich, Vienna, Budapest, Bratislava, Brno and Prague. The rest of the term, from August 1 to September 16, will be devoted to excavations at Homolka, near Prague. It is also planned to have a second group of students for a shorter term (July 1 to August 1) and a less intensive program. Further information may be obtained from Professor George Grant MacCurdy, Peabody Museum, New Haven, Connecticut.

ON March 5 the governor of Kansas approved a bill changing the name of Kansas State Agricultural College to Kansas State College of Agriculture and Applied Science. The adoption of the more inclusive name is said not to involve or imply any change in the aims, character or work of the college.

THE *Journal* of the American Medical Association says: "When the University of Southern California Medical School was first opened the dean was enabled to secure a corps of well-qualified teachers, under the belief that other needed improvements would be made. For that reason, at a business meeting of the Council on Medical Education and Hos-

pitals of the American Medical Association held in June, 1930, the council voted that an acceptable rating be granted for the students who had completed their first two years of medical work during the years 1928–1929 and 1929–1930 under the faculty thus secured, but that an acceptable rating for the medical school be withheld in the hope that further improvements deemed essential would be made. Recent information obtained from reliable sources, however, indicated that, instead of making further improvements, actually retrogressive measures had been adopted. At a business meeting of the council held on February 15, therefore, the council had no other alternative than to vote that an acceptable status for this medical school be not granted."

IT is announced that a school of medicine will be organized as a part of the Louisiana State University. Premedical work and the first two years for the medical work will be given at Baton Rouge, and the last two years will be given in connection with the Charity Hospital at New Orleans. Dr. Arthur A. Vidrine, superintendent of Charity Hospital, has been named dean.

THE U. S. Civil Service Commission announces the following competitive examinations: physicist, at $3,800 a year, associate physicist, $3,200, and assistant physicist, $2,600. The optional subjects are: Heat, electricity, mechanics, light, radio, physical metallurgy, thermodynamics and aerodynamics, and any specialized work in the field of physics not included in any of the above. Applications for these positions must be on file not later than March 25. The examinations are to fill vacancies in the Bureau of Standards and Bureau of Mines, and under the National Advisory Committee for Aeronautics. Applications for the position of park historian, $3,800 to $4,600 a year, associate park historian, $3,200 to $3,800, and assistant park historian, $2,600 to $3,200, must also be received not later than March 25. The examinations are to fill vacancies occurring in the National Park Service. There are present vacancies at the Colonial National Monument, Yorktown, Virginia. The duties are to carry on historical, educational and museum work in the fields of history. In the case of all these examinations competitors will not be required to report for examination at any place, but will be rated on their education and experience, and on a thesis or published writing.

PLANS have been announced for the annual trip of the Harvard Summer School of Geology. The locality which will be studied in detail will be the north central part of New Mexico, in the Nacimiento and Jemez Mountains. Instruction will be conducted by Professor Kirk Bryan, who has made a geological study of this area. Six days a week will be devoted to mapping and to studies of land-forms in this part of the country. The second part of the summer will be spent in a rapid reconnaissance, covering 1,500 miles in New Mexico, Colorado and the north of Texas. The traveling will be done by truck, and the party will usually camp out. The first place that will be visited is the northern basin of the Rio Grande, where ancient lakes will be studied. From there the party will go to the salt lakes in the enclosed basin of the Estancia, and across the plains of eastern New Mexico, ending at the Carlsbad Caverns. The trip will cost $175, meals included, starting at Albuquerque, and it will count as a half course in the university. Enrolment is limited to those who have completed at least a full year of study in geology.

ACCORDING to a report in the *Journal* of the American Medical Association, obtained from the American representative of the Soviet Red Cross Societies, medical education in the Union of Socialist Soviet Republics, which was reorganized in 1930, now has three divisions, or faculties. These are (1) the curative-prophylactic faculty, which is divided into surgical, therapeutic and stomatologic departments; (2) the sanitary-prophylactic faculty, which is divided into epidemiologic, communal housing, nourishment and sanitary-industrial departments, and (3) the faculty for the protection of motherhood and childhood, which has two departments, one for mothers and infants, the other for children and adolescents. Except in the second division and the stomatologic department of the first, medical instruction covers four years. After a year's internship, graduates of the curative-prophylactic faculty and of the faculty for the protection of motherhood and childhood have the right to practice medicine independently. Physicians who have received their medical training outside of Russia may practice only after they have completed one year of practical medical work in institutions controlled by the commissariat of health. Applicants must also pass examinations on the principles of Soviet health protection.

THE National Tuberculosis Association announces a limited number of fellowships in social research as related to tuberculosis, open to graduate students who have had special training in statistics, social science or public health. Preference will be given to candidates who are interested in pursuing research in public health after the completion of this fellowship. Researches on topics selected by the National Tuberculosis Association will be conducted in collaboration with colleges and universities, and each study will be under qualified academic leadership. Academic credit

may be allowed for this research according to arrangement with the individual universities under whose supervision they are undertaken. Each fellow will be required to submit a written report at the completion of his fellowship grant and the text of that report shall remain the property of the National Tuberculosis Association. Candidates will be considered not alone on academic standing, but on experience and general fitness for research work. The fellowship grants will date from the beginning of the academic year in the fall of 1931. They are for a twelvemonth period and the fellowship grant amounts to $1,500 for that period with a month's leave for vacation. Interested candidates should write to Jessamine S. Whitney, Statistician, National Tuberculosis Association, 370 Seventh Avenue, New York City, for further information.

ACCORDING to the London *Times* an advisory Standing Commission on the British National Museums and Galleries is in process of formation. It is understood that the following have been invited to serve upon the commission: The Earl of Harewood, Lord Hanworth, Mr. C. R. Peers, Sir Richard Glazebrook and Sir Henry Miers. The creation of such a standing commission, which should review each year the draft estimates of the National Museums and Galleries, and advise generally upon the position, was among the recommendations of the Royal Commission on National Museums and Galleries. While such a body is intended principally to act as mediator between the various institutions and the treasury with a view to discouraging extravagance and assessing rival claims, it was suggested by the Royal Commission that it could also promote coordination between the national and provincial museums, and incidentally stimulate private benefactions. The function of the commission will, it is understood, be purely advisory, and it will not have executive control, apart from any influence exercised through the treasury or other government offices, over the trustees and similar bodies which at present govern the various institutions.

DISCUSSION

DEPOSITION OF SEDIMENT IN LAKES BY GLACIAL STREAMS

ON June 13, 1930, the writer had the opportunity to observe, from the deck of a steamer, the discharge of the Rhone River into Lake Geneva. At this time there was rapid melting of snow from the mountains and of the ice of the Rhone Glacier (seen about a week later) and the river was a yellow flood of cold water. From thermometric observations made on similar streams in Alaska, in 1909, it may be inferred that these snow and glacially derived waters of the Rhone had a temperature only a few degrees Fahrenheit above the freezing point, that is, they were within the temperature range where fresh water is most dense. The surface waters of the lake, on the other hand, were sufficiently warm to attract a few bathers to a beach at the head of the lake, a mile or two distant from the Rhone outlet.

Immediately on coming in contact with the lake waters, at what was evidently the edge of the steep, fore-set slope of the delta, the river waters sank beneath the surface. The demarcation between the blue waters of the lake and the yellow waters of the river flood was of line-sharpness; no zone or belt of turbidity could be seen, nor was there any turbidity of the surface waters of the lake at distances farther out in the lake. At the line of disappearance the yellow river waters had still a strong current, to the degree of being rippled on the surface; a current probably competent to transport coarse sand in suspension. The line of separation between the lake and river waters made the pattern of a delta with the base, in the lake, generally straight, and several times longer than the stream width at the apex of the triangle. In detail this base-line front of the delta had a crenate outline; a pattern that served to round off the angles between the base and the other two sides of the triangle.

From these observations it would appear that where the waters of a glacial stream, at temperatures where water is of maximum density, empty into a body of fresh water with relatively warm surface layers, sinking of the cold waters, together with their sediment load, is abrupt and complete at the outer edge of the top-set beds. Accordingly, if the water of the lake is of adequate depth in relation to the developed thickness of the delta deposit the fore-set beds should be of the maximum steepness permitted by the angle of rest under water of the material deposited. Further, their composition and cross bedding should be comparably heterogeneous to that of the top-set beds.

These deductions are fulfilled in a marked degree by the form and composition of the hanging deltas built into proglacial lakes at various levels, as found in the Finger Lakes district of central New York. The higher levels of such deltas quite invariably have very steep fronts, forty and more feet high, with straight rather than curved or serrate outlines. Where such delta terraces have been cut through in building operations or for use as a source of sand and gravel they show little difference in composition or coarseness of materials between the top-set and fore-set beds.

While there is such correspondence between the

form of the deltas deposited in the proglacial lakes and the process observed at the Rhone River-Lake Geneva junction, it is probable that the deposition of the deltas in the proglacial lakes was only exceptionally done under the extreme conditions of temperature difference present at the Rhone River-Lake Geneva site. It may be presumed that the surface waters of the proglacial lakes were ordinarily colder and that the stream waters were warmer and chiefly derived from precipitation on land. However when the higher level terraces of these delta deposits were made the streams were in part, at least, fed by ice melting.

On June 15, 1930, the conditions and phenomena noted at the Rhone mouth in Lake Geneva were also observed where the Lutschinen stream from the Lauterbrunnen valley empties into the Lake of Brienz at Interlaken. At this site the lake waters at the delta front were very shallow and the sediment load was so great that the advance of the front of the delta might be said to be quite entirely brought about by top-set beds. That is, there was the same abrupt checking of the current of the stream as with the Rhone but the Lutschinen was visibly transporting coarse gravel to the line of disappearance of the glacial flood.

In contrast with these conditions are those present at the mouth of the Cayuga Inlet stream that enters the south end of Cayuga Lake, New York. There the stream waters are, during spring and early summer, commonly warmer than the lake waters, especially in periods following a prevailing south wind. Consequently it is a conspicuous phenomena that the lake waters during flood flows of the Inlet stream are discolored for a half mile or more out from the mouth of the stream. The lake waters over this section are very shallow, the bottom having a very gentle slope. In this instance the colder lake waters appear to exert a significant effect in buoying up the finer sediment and giving it a wide-spread deposition.

In addition to their bearing on the interpretation of delta forms and deposits generally these observations may have some significance in relation to the conditions under which deposition of varved clays in glacial lakes comes about.

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SUFFOCATION POINT IN THE HORNED LIZARD, PHRYNOSOMA CORNUTUM

THE horned "toad" or horned "frog," as this lizard is commonly called, has won a great deal of publicity in recent years concerning its ability to withstand suffocation and starvation for long periods of time. The following article will serve to supply some definite information on its hardiness and lethal point in respect to suffocation. Two series of a number of different individuals each were used, and the results seem fairly consistent. One series was run in respiratory chambers where the carbon dioxide discharged by the animal was allowed to remain and accumulate, while in the other series, soda lime was used to absorb the carbon dioxide as it was produced.

The animals were placed in stoppered bottles, properly arranged to serve as respiratory chambers. The size of these chambers was between 900 and 1,000 cc in volume. When the animal had been kept in the respiratory chamber for the desired length of time at a known temperature and in a known volume of air, a sample of about 9.5 cc of the air was drawn from the outlet of the chamber directly into a portable Haldane gas analysis apparatus and analyzed for carbon dioxide and oxygen. The weight of the animal was also noted in each case. The samples were taken either immediately after the animal was dead or after it was in great distress, shown by labored gasping and struggling, which indicated that it would very soon die if allowed to remain in the chamber.

According to the results of these experiments, the animals which were actually carried through until death in the chambers where the carbon dioxide was allowed to accumulate consumed the oxygen down to a point where the air in the chamber contained between 4 and 5½ per cent. oxygen. Normal air contains about 20.93 per cent. oxygen. Carbon dioxide was produced in these chambers until it reached percentages ranging from 12 to 15 in different individuals at death, while normal air contains only approximately .03 per cent. The other animals included in the series, which were at their limit and would have died very soon, show an oxygen and carbon dioxide range that is very similar to the range for the ones which were killed.

The second series of experiments, where the carbon dioxide was absorbed, show the animals reaching the lethal point of suffocation only after the oxygen content of the respiratory chamber has gone down to 3.21 per cent. on the average. One or two individuals in the first series were able to survive until the oxygen content went down to about 4 per cent., but this was not the rule. It is seen immediately that the carbon dioxide effect is quite marked here.

The larger animals of course consume more oxygen and can survive a much shorter time than a smaller animal in a chamber of similar size. As would be expected, the temperature affects the rate of respiration quite sharply in this lizard, especially during the summer, and of course enters prominently into the

length of the survival time in a limited volume of air. These animals do not struggle or move about to any extent so that the metabolic factor did not influence the survival time to any great degree in these experiments.

At temperatures of 23° to 26° C., specimens of the average weight of those used above will survive in a liter bottle for ten days or more before the point of suffocation is reached. At 35° C. the point of suffocation is reached in two or three days in bottles of similar size. When the temperature is down to about 10° C. with the animals in hibernation, it has been found that those of the average size, as considered above, will live for about two months in a liter chamber of air.

These experiments, which are only a part of more extensive ones, give a rather definite idea of the lethal point for suffocation in oxygen percentages and carbon dioxide percentages for this animal, as well as reviewing the factors influencing the survival time. This is a preliminary report.

GEORGE E. POTTER

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GRADUAL OBLITERATION OF THE PORTAL VEIN AS A SUBSTITUTE FOR ECK-FISTULA[1]

THE diversion of the portal blood directly into the vena cava was accomplished by N. V. Eck[2] in 1877 by means of the fistula which bears his name. This procedure has been exceedingly useful in the study of many problems concerned with the physiology of the liver and organs whose venous blood drains into the portal system. Its application has been somewhat limited by the technical difficulties of the operation, particularly for those not trained in blood vessel surgery. During the past three years the author and associates, J. C. Ellis and W. B. Mathews, have made use of a more simple method for accomplishing the same purpose. It consists essentially in producing so gradual an obstruction to the portal vein that the collateral anastomoses in the esophagus and rectum develop sufficiently to prevent gangrene of the intestines. This may be accomplished by means of a two-stage operation in the dog, cat, goat, rabbit and rat. At the first operation, the portal vein is carefully isolated and two strong linen threads introduced around it above the entrance of the pancreatic-duodenal branch. One of these threads is then tied sufficiently to produce a constriction of the portal vein to about one half of its normal diameter. A slight congestion of the intestines may occur which rapidly disappears. The ends of the second thread are then fastened to the abdominal wall so they may be readily found at the second operation. The second operation may be done two to three weeks later, at which time the portal vein is completely occluded. Gangrene of the intestines does not occur. The operation is very simple and there is practically no mortality. A demonstration was made of this method at the meeting of the American Physiological Society in Chicago in April, 1930. It is altogether probable that many others have used this or a similar method before. I have been prompted to publish this note because of the many requests received during the past year for details of the method. We have used it successfully on the various laboratory animals listed above.

LESTER R. DRAGSTEDT

[1] From the Department of Surgery of the University of Chicago.

[2] N. V. Eck, *Militar-medicinisches Journal*, 1877, cxxx, Jahrgang 55. Travaux de la Soc. des Naturalists de St. Petersburg, 1879, x. 55.

DEVIL'S SHOE-STRING AS AN INSECTICIDE[1]

THE investigator's attention was attracted to the possibilities of devil's shoe-string, *Cracca virginiana* Linn., as an insecticide three years ago through studies of derris, and particularly through the physiological action of derris on fish. The roots of both plants are powerful fish-poisons and, from all accounts, affect fish in a similar way. No references in literature have been found where this species has ever been used for insecticidal purposes; however, studies have been made by several investigators of foreign species of this genus. The most important studies were made by F. Tattersfield, C. T. Gimingham and H. M. Morris.[2]

Roots were dug from several localities at various times of the year and were dried by different methods. They were then finely ground in an herb mill. Careful and repeated experiments with aqueous suspensions were made under laboratory conditions on the cotton or melon aphis, *Aphis gossypii*. Marked variations in toxicity were found, due to the season, soil, method of drying and probably various other factors. The most toxic samples were obtained from sandy soil, dug in the hottest part of the year and dried in the sun. Drying in the shade, boiling in water and heating the roots caused a loss in toxicity. Comparative data with nicotine sulphate (40 per cent.), and aqueous suspensions of derris and a commercial brand of pyrethrum showed that the best samples of devil's shoe-string were slightly more toxic than pyrethrum, but were less toxic than derris; however, they compared more favorably with derris than derris with nicotine sulphate (40 per cent.).

[1] Contribution No. 24, Department of Entomology, Texas A. and M. College, College Station, Texas.

[2] "Studies on Contact Insecticides," Parts 1 and 2, Vol. 12, and Part 4, Vol. 13, Annals of Applied Biology.

Observations showed that devil's shoe-string kills in a manner similar to that of derris. Its action is as quick or even more so, but it takes a somewhat longer time for the insects to die. It kills through paralysis and perhaps also through interference with respiration.

Field experiments on plant lice, *Aphis gossypii* and *Rhophalosiphon pseudobrassicae,* tent caterpillars, *Malacosoma americana,* yellow-necked caterpillars, *Datana ministra,* and Colorado potato beetle larvae, *Leptinotarsa decemlineata,* showed that the plant has considerable promise as a contact spray. But it possibly has greater promise for the control of various animal parasites. Almost perfect results were obtained on various species of fleas and lice; and encouraging results were obtained on cattle grubs, *Hypoderma lineatum.*

The supply at present is probably adequate for commercial purposes; but due to marked variations in the toxicity of the plant, it may not be possible to wholly utilize the available supply. Its commercial possibilities probably depend upon how cheaply it can be grown and harvested. A more detailed article will soon appear elsewhere.

V. A. LITTLE

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BIOCHEMISTRY IN RELATION TO INTELLIGENCE

MANY people seem willing to believe that the chemicals in one's body may affect one's mind; but, apparently, scientific literature has been extremely vague or altogether silent on the subject, except in the case of glandular secretions, certain drugs and the like.

In an attempt to determine whether there is a characteristic chemical difference between "intelligent" persons and idiots, blood tests were made on 12 normal or superior persons and 20 idiots. All the subjects were adults of approximately the same age and health, and in each group there was an equal number of males and females. Differences in diet were made note of, and the time of day at which blood was taken and the interval elapsing before the tests were kept fairly constant.

The Clark-Collip modification of the Kramer-Tisdall method was used for the determination of calcium, with the result that practically every case came within the normal range; all the idiots were normal in their calcium-content.

The Fiske-Subbarrow method was used for the determination of inorganic phosphate in blood plasma. The phosphate-content of the normal group was found to range between 3.25 and 8 mg per 100 cc of blood, but in only one case was it above 5.88 mg and in that case a retest one month later showed 3.01 instead of 8 mg, suggesting that the excess was temporary. Without a single exception, the idiots had a high phosphate content, ranging from 5.98 to 12.48 mg and averaging 8.95 mg per 100 cc of blood, as compared with an average of 4.36 mg for the normal group.

No characteristic sex differences appeared in calcium or phosphorus, and there was no reciprocal relation between the amount of calcium and that of phosphorus, especially in the case of the idiots.

Several other experiments on this general subject are in progress.

H. D. POWERS

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THE LANGUAGE OF A CLERGYMAN

IT was gratifying to find that my modest paper on "The Language of Scientists," printed in SCIENCE for December 5, 1930, excited some interest. I had very appreciative and helpful letters from various parts of the country and from men engaged in many different scientific specialties, showing that the points treated of were considered important and timely.

And now I have the valuable criticisms of two correspondents in SCIENCE for January 16, 1931. I enjoyed reading these as much as I suppose the writers enjoyed making their very appropriate comments.

It was hardly fair, however, to visit the errors of this one poor sinner on the whole class of clergymen. To be sure I know many of them who say "dioseize" for "dioceses," who make three syllables of "Reredos" and who even will put the accent on the penult of "deficit," but as a class I am not aware that they are particularly weak on rhetoric, as I seem to be. At any rate this clergyman will try to be more careful in future and to get some keen-nosed rhetorician to revise anything he may prepare for publication.

There is only one word to which I take exception. Dr. Theodore W. Darnell, of New York (I do not know him, but I am sure he must be a Litt.D.), speaks of my "castigation" of my fellow members. Now this was just what I had no intention of administering. I wrote in a humble and sympathetic spirit and hoped that none would feel that I was being censorious in the ordinary meaning of the word. In fact one of my correspondents voluntarily congratulated me on my success in this particular. But the effect of the written word depends, not only on the disposition of the writer, but also on that of the reader. This latter it is impossible to guard against entirely. To point out errors is neither a pleasant task nor likely to excite gratitude in one who feels that he is himself perhaps guilty of some of them. I did not spare myself and told of my own mistakes and said that *we* were all *liable* to err instead of charging, "*You* are all *likely* to err."

And really I am a little disappointed in Dr. Darnell. After all my efforts to point out the undesirability of using mongrel words, he asks whether "supercritical" or "hypercritical" is correct, and seems to imply a preference for the Latin-Greek hybrid rather than for the nice, pure Greek compound.

GEORGE W. LAY

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SCIENTIFIC BOOKS

The Stars of High Luminosity. Harvard Observatory Monograph No. 3. By CECILIA H. PAYNE. New York and London, McGraw-Hill Book Company, Inc., 1930, 8-vo. pp. ix, 320. Price $3.50.

IN 1925, Miss Payne published her first book on "Stellar Atmospheres" as No. 1 of the series of Harvard Monographs. The volume had a notable success. Not only astronomers, but also physicists and physical chemists found in it a much-needed summary of the maze of observational data which had accumulated since the discovery of the spectroscope. The theory of ionization was then less than five years old, and it was particularly appropriate to discuss the data from the point of view of the new theory. Since that time more than five years have passed. The theory has been greatly extended, the technique of measuring the intensities of spectral lines has been improved and adapted to the requirements of the theory, and a great amount of observational material has been accumulated. Since "Stellar Atmospheres" is now out of print and many parts of it out of date, Miss Payne has written an entirely new book which is to supersede and to complete her earlier volume.

The title of the new book is somewhat misleading. It covers a far wider ground than its narrow, perhaps even slightly artificial name, "The Stars of High Luminosity," might indicate. It is in fact a "physical study of stars by means of their spectra," as the first sentence of the book states, and it covers the subject of "Stellar Atmospheres" no less completely than did her first work.

The new book covers an epoch in observational astrophysics. It is one of those rare books that treat a whole field of knowledge from the purely scientific point of view and do not attempt the impossible in catering to the professional astronomer and to the layman at the same time. In a volume of 320 pages, neatly printed on excellent paper, Miss Payne has given a summary of her work and her ideas on the subject of the physical interpretation of stellar spectra. In a clear and vivid style she has given an account of the ionization theory and of various related subjects, primarily from the observational point of view. Being purely "scientific," a layman will get little out of it, but it will be highly appreciated by the scientific world. Astronomers, and perhaps even to a greater degree physicists and chemists, will find here a collection and a critical analysis of the many important facts that observations of stellar spectra have revealed.

The point of view which the author adopts in her new book is distinctly less objective than the one used in "Stellar Atmospheres." Apparently her intention has been more to give an account of her individual research rather than a balanced summary of all knowledge on the subject. As she states in the introduction: "It (the book) carries the work as far as I believe it can be carried with the kind of material available to me—spectra of comparatively short dispersion, either unstandardized or standardized by simple and unrefined methods."

The book falls naturally into four major parts. In the first the author discusses briefly the methods employed in modern spectro-photometric investigations, and the theoretical foundations of the work.

It has been known for some time that stellar absorption lines are not infinitely narrow, nor do they cut out all of the light from the continuous spectrum. Careful analysis has revealed that some lines are wide, while others are narrow; in some the amount of radiation that is cut out from the continuous spectrum is great, while in others it is small. The first task of the investigator is to measure the contours of the absorption lines and to attempt to obtain from these measurements information concerning the physical character of the outer atmospheres of the stars. Physical theory has been helpful in this respect. Through the work of Unsöld and of Stewart, to name only two of the whole succession of brilliant physicists who have worked on this problem, we have definite information as to the manner in which an atom absorbs when it is struck by a quantum of light: it appears that certain very definite laws concerning this absorption can be formulated, and from them important conclusions can be drawn with respect to what is called "the number of active atoms in the atmosphere of a star." In reality this number refers to all the atoms above a certain level in the atmosphere, and E. A. Milne has shown how this level can be determined. Miss Payne adopts the method of expressing her measurements in numbers of atoms, and all of the results contained in the book are more or less closely related to this procedure.

The second part of the book is entitled "The Material." This does not refer to the spectroscopic data

resulting from her measurements, for these form the essence of the following part, "Results of Observation." She discusses the character of the stars which she has investigated, and defines the meaning of the term "stars of high luminosity." There is some uncertainty in the distinction between stars of high luminosity and stars of low luminosity, but a line must be drawn somewhere and Miss Payne places it at absolute magnitude −2.0. The book is primarily concerned with stars which are brighter than this value, but since her method involves a comparison of luminous stars with normal stars, she has included in her discussion virtually all types of stellar spectra.

The nucleus of the book is Part III entitled "Results of Observation" and covering a total of 190 pages. The various spectral types are taken up one by one, and the spectral differences between normal stars and high-luminosity stars are discussed for the more conspicuous spectroscopic features. The inclusion of a separate chapter on "The Variable Star" seems especially appropriate. This chapter more than any of the others illustrates how much remains to be done on the subject of high-luminosity stars. There are many correlations and an even greater accumulation of observational data. But no clear understanding of the nature of a "variable star" is as yet available.

In the chapters that deal with the earlier spectral types one is struck by the change in the temperature scale for the hottest stars, compared with the one adopted by Miss Payne five years ago. It has usually been believed that early B-type stars have a temperature in their reversing layers of the order of 20000 °C. Miss Payne now adopts the very much lower value of 13200°. The reason is obvious. The theory of ionization, as used in the method of maxima of Fowler and Milne, does not directly yield the temperature. It can and does establish a certain relationship between pressure and temperature, but one of these two factors must be known beforehand, only in that case can the other be evaluated. The work of Fowler and Milne has pointed this out very clearly. It was only a reasonable guess, an assumption, on their part that the pressures in all reversing layers, irrespective of spectral type, were of the order of 10^{-4} atm. Assuming this to be true the old temperature scale was derived. But there is no reason to believe that the pressure must be the same in all types of stars. In the later types, approaching the sun, we depend upon the energy-distribution of the continuous spectrum to give us the temperature. The pressure is then derived from the ionization formula. In order to be consistent we should adopt in earlier spectral classes, too, the temperatures as given by the energy-distribution, and then determine the pressure. The result is surprising. The energy-distribution points unmistakably to very low temperatures for many of the stars of earliest spectral types, and the resulting pressures are of the order of 10^{-13} atm. There is a large amount of evidence against such low pressure and Miss Payne very correctly rejects this interpretation. We are left with the disquieting necessity of doubting the evidence of the continuous spectra: the distribution of the energy as a function of wave-length does not give us the true temperatures of the stars. But what is then left of our temperature scale? On the one side we are not willing to adopt equal pressures for all spectral types; on the other we find that what we thought was the only trustworthy method of deriving stellar temperatures is giving us erroneous results. The first problem is, of course, to investigate the causes which make the method fail. Is it due to a real failure of the light of the stars to conform to the radiation law of black bodies, or is the light of the stars changed in passing through interstellar space? Miss Payne adopts the first alternative and dismisses the second rather briefly. But her reasons for doing so are perhaps not binding. She suggests that there is a departure from black-body radiation which makes itself manifest in the form of a violet depression in the more luminous B-type stars. If the color temperature is determined from the range of wave-lengths affected by the depression, we should obtain low temperatures. On the other hand, were we to go further into the ultra-violet, we should gradually come back to the true temperature distribution, and no anomaly would be observed. This idea the author supports by the statement that the photoelectrically determined color-indices by Bottlinger show less reddening effect than direct spectro-photometric measurements made at Harvard for the same stars. She suggests that this is due to the difference in color-sensitivity of the two methods: the sensitive point of Bottlinger's measurements being to the violet of that of the Harvard measures. But is this really so? Bottlinger used a potassium cell with a violet filter having maximum sensitivity at λ 3650. The whole instrument was attached to a refracting telescope. Surely the maximum sensitivity of the combination could not have been much to the violet of λ 4000, and indeed, Bottlinger himself suggests that the radiation to the violet of this point was without effect upon his measurements.[1] Compare this with the recent spectro-photometric results of Trumpler (not available when Miss Payne's book was written). Here a quartz spectrograph was used attached to a reflector. The microphotometer curves extend to about λ 3400, and no evidence of any depression is visible. But the effect of reddening is very pronounced.

[1] Sensitivity curves for Bottlinger's measurements are given in Handbuch der Astrophysik 2, 361, 1929. The maxima are at λ 4300 and λ 4700.

The crucial test would, of course, consist in the determination of color-temperatures of groups of stars in open clusters, where all the members are known to be at the same distance. If the hypothesis of Miss Payne is correct, the more luminous stars should show more pronounced reddening than the less luminous stars of the same spectral types. If Trumpler is right, the amount of reddening should be the same for all stars. Miss Payne mentions in this connection the work of Balanovsky and states that there is some evidence in his results favoring her point of view, but she states that "quantitative estimates of the temperature can not be made from his discussion."

Incidentally it may be noted that there is a correlation between reddening of B-type stars and intensity of the interstellar calcium lines, and, contrary to the statement of Miss Payne's book on page 120, there is a very pronounced concentration of red B-type stars in the very region where some of the strongest interstellar lines are observed (in the constellation Cepheus and in adjoining regions). But this does not mean that the reddening may be caused by the calcium itself: the amount of matter, in the form of ionized calcium, in the line of sight between the observer and some of the most distant stars is not more than is contained in one cubic centimeter of air at normal pressure and temperature. It is clear that so small an amount of matter could never produce the enormous amount of reddening observed by Trumpler and by others.

Whatever the outcome of this extremely interesting problem may be, we are left with the unsatisfactory state of our present temperature scale. Future work will have to deal with this side of astrophysics, and will have to devise new methods by which this scale may be ascertained. If the reddening should turn out to be due to interstellar absorption, then there would be no reason to question the radiation laws. The nearer stars would give us more nearly correct temperatures than the more distant stars, and an extrapolation should enable us to get the energy-distribution for zero distance. If, however, space reddening is not present, the matter would be more complicated. Perhaps the study of the Stark effect in stellar spectra may help to establish another function of temperature and pressure. It should then be possible from this and from the ionization formula to evaluate pressure and temperature independently. Even now it is possible to say, from the Stark effect alone, that pressures of the order of 10^{-13} atm. are not possible, and that consequently the energy-distributions can not be taken at their face value. An independent determination of the temperature scale could perhaps be obtained by a method similar to the one used by Adams and Russell in 1928.

Speaking of the ionic Stark effect, it is of interest to note that Miss Payne finds evidence of its existence, at least in spectral class A. The question might justly be asked: if ionic Stark effect is present, is it permissible to apply the Unsöld formula to the evaluation of the numbers of atoms? Strictly speaking the absorption coefficient in a line affected by Stark effect is not that given by the classical theory (as was pointed out by Unsöld) and the formulae which may be used for lines produced by radiation damping are not applicable. But it is fairly safe to say that the discrepancy will not be a serious one and that the numbers obtained will at least be comparable to those that would apply in the case of no Stark effect.

The last part, "Analysis of Stellar Atmospheres," gives a short summary of the observational results described in the preceding chapters and discusses them, rather briefly, in the light of the "generalized" ionization equations of Milne.

There are many useful tables in the book. A complete list of O stars, a catalogue of stars showing the so-called c-characteristic in their spectra, and a list of Cepheid variables add greatly to the value of the volume.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A NOTE ON CAPSULE STAINING

SOME difficulty in securing good results is frequently encountered in the routine laboratory exercise on staining capsules by the well-known method of Hiss.[1] In an effort to make this procedure more adaptable to class use several variations have been tried and a series of dyes compared by various procedures. The dyes tested were as follows: crystal violet, 84 per cent., crystal violet, 92 per cent., crystal violet (dye content not stated), methyl green, gentian violet, methyl violet 1 B, methyl violet 2 B (two brands) and aniline violet. The organisms were pneumococcus from the peritoneal cavity of an infected mouse and Klebsiella pneumoniae from serum agar slants. Thin smears were made without the use of a diluent; the films were allowed to dry in the air and stained without fixation.

Methyl green was not found to be a satisfactory stain by any of the procedures tested. More or less

[1] P. H. Hiss, Jr., "A Contribution to the Physiological Differentiation of Pneumococcus and Streptococcus, and to Methods of Staining Capsules," *Jour. Exper. Med.*, 6, 317, 1905.

satisfactory preparations could be obtained with most of the other stains, but the best results were from the use of a 1 per cent. aqueous solution of crystal violet, 84 per cent. dye content. The staining was carried out in the cold for two minutes. The slide was then washed with 20 per cent. copper sulfate in the usual way and blotted dry. Better differentiation was obtained by this procedure than by any other method tested. An increase of the staining time did not improve the results obtained.

The procedure given above has been tried out in class with practically no failures, a condition which rarely prevailed with the original method of Hiss.

In view of the fact that the method here given does not require steaming in order to secure satisfactory results in a short period of time, it is felt that it is to some extent an improvement over the earlier method. An added advantage is to be found in the fact that the staining solution is the same as the primary stain of the Kopeloff and Beerman modification of the Gram stain, this being one of the methods recommended in the "Manual of Methods" of the Society of American Bacteriologists.[2]

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PREPARATION OF BEE SLIDES

THE following combination of methods has been found very satisfactory for clearing and mounting the chitinous skeletons of insects. It is particularly adaptable to the preparation of the head and mouth parts, the legs, or total mounts of bees, when they are to be used for the gross study of the skeletal structures.

When preparing mounts of each of the three types of legs and the head, the desired number of each are removed and each group tied up in small cheesecloth bags so that they may be handled more easily during the first part of the process.

The bags are placed in a small porcelain dish and covered with a solution of 20 per cent. potassium hydroxide, and boiled for 15 to 30 minutes.[1] As the water evaporates more of the solution is added so that the concentration is increased during the boiling. Remove the bags and wash in running water for 12 hours. Pressing the bags gently and then releasing them several times at two or three hour intervals assists greatly in thoroughly washing out the cavities in the skeletons.

When washed, the parts are bleached to the shade best suited for study. For bleaching Mayer's Chlorine Method[2] is used. For the bee preparations the following proportions were found to give best results: Concentrated HCl 3 cc, 70 per cent. alcohol 10 cc. This is put in a small vial and to it is added potassium chlorate, a few crystals at a time. The parts to be bleached are put in the solution and left until the desired shade is obtained. More of the potassium chlorate is added each time the liberation of chlorine ceases. The parts can be bleached to a creamy white and stained, but it has been found quite as satisfactory to bleach until the color is a light tan, no staining being necessary. It is advisable to remove the parts from the bags and treat a few at a time so that the amount of bleaching can be regulated.

When the parts are removed from the bleach they must be handled with care until after hardening. Wash in four or five changes of distilled water for 30 minutes. The heads are now placed on a slide in a drop of water and the mouth parts arranged under a lens. A second slide is placed on top and the two pressed together to flatten the head. See that the mouth parts are not disarranged, and then put a rubber band or clip around both slides and place in 80 per cent. alcohol for one hour. Drain and put in 95 per cent. for one hour. The parts are now hardened in position and can be removed from the slides and placed in absolute alcohol. The other parts which do not need flattening are carried through the same procedure all together. Use two changes of absolute, one hour and two hours, then clear in clove oil for 24 hours. Mount in balsam.

Total bees can be fixed in the same manner and suitably arranged before hardening. By careful pressing the total bee or bee's head can be flattened so that it is no thicker than a No. 1 cover-glass.

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CHEMICAL TREATMENTS TO SHORTEN THE REST PERIOD OF TREE SEEDS

IN the past three years it has been demonstrated that the dormant seeds of sugar maple, Norway maple and the acorns of black oak and red oak can be stimulated into germination by treatments with solutions of thiourea and ethylene chlorhydrin and by the vapors of ethylene chlorhydrin. While full details of these investigations will be published later it is thought desirable to make available the methods which have given the best results to date.

With sugar maple and Norway maple seeds, immersion of the seeds in a 3 per cent. solution of thiourea for 1 minute proved to be the most successful treatment. The solution was drained off the seeds and the bottle stoppered and the seeds allowed to

[2] "Manual of Methods for Pure Culture Study of Bacteria," Society of American Bacteriologists, Geneva, 1928.

[1] Mayer, "Chlorine Method." McClung, "Microscopical Technique," p. 478, and Guyer, 1st ed. p. 45.

[2] KOH for softening. Kingsbury and Johannsen, "Histological Technique," p. 130, par. 313. Lee, "Vade Mecum," 7th ed. par. 551.

stand for a day before planting. Immersing the seeds in 3 and 6 per cent. solutions of ethylene chlorhydrin (made by mixing 6 and 12 milliliters, respectively, of ethylene chlorhydrin, technical, with 194 and 188 milliliters of water) also was effective. The seeds were immersed for a minute, the solution poured off of them and the bottle stoppered for twenty-four hours before planting.

With black and red oak acorns consistently good results have been obtained by subjecting 50 or 100 acorns in a liter wide-mouth bottle to the vapors of four milliliters of ethylene chlorhydrin, technical, for twenty-four hours. The chemical was placed on a five-inch square of cheesecloth suspended from the stopper. This treatment initiated germination of acorns gathered in October within four weeks and within ten weeks more than 70 per cent. had germinated while the acorns not treated showed 1 per cent. or no germination. Immersion of these acorns in a 3 per cent. solution of thiourea for 15 minutes was effective but slower than the ethylene chlorhydrin vapor treatment. Germination in acorns treated with thiourea solution did not start until the seventh to tenth week after treatment.

It is not claimed that the procedures described are the best methods of hastening dormant tree seeds into germination with chemicals since much more work needs to be done upon the most effective concentrations of the chemicals and the most effective time periods of treatment but these chemicals do give a new mode of attack upon dormancy in seeds. The results reported are based on tests made with more than 9,000 maple seeds and 5,000 acorns.

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SPECIAL ARTICLES

THE BIOLOGICAL EFFECT OF HIGH VOLTAGE X-RAYS

FOR many years radiologists have debated the question whether equal doses of X-rays of different wave-lengths produce the same or different quantitative biological effects, a problem of practical importance in therapy. The chief obstacles in deciding the matter were the lack of a standard unit of X-ray intensity, the lack of adequate measuring apparatus and the highly variable character of the biological materials which were used in making the tests. The adoption of a standard unit, the Roentgen, now permits an accurate definition of dosage, where previously none was possible. The question now is this: When a definite number of r units, measured by an air ionization chamber, is delivered to a suitable material, will the amount of effect which is produced vary with the wave-length of the beam, that is, with the voltage.

An almost ideal biological material consists of the eggs of the wild fruit fly, Drosophila. These eggs when freshly laid are comparatively sensitive, and are remarkably uniform in response. Different strains of wild flies are apparently equally radiosensitive. Therefore one may make experiments with them anywhere with the assurance that his results will be comparable with those obtained by other workers at other places.

A long series of tests[1] with carefully measured beams produced at constant potentials shows that the mortality curve has an asymmetrical sigmoid shape. These tests were made with different wave-lengths, (0.20, 0.50 and 0.70 A. U.), that is, with hard, medium and soft X-rays. In each instance the results showed that the quality of the beam has no effect on the mortality rate; it is the intensity which is the deciding factor. Furthermore, the course of the curve is the same in each case. From such a curve we can determine how many r units are required to kill any percentage of eggs in a sample.

The method may be reversed.[2] By knowing how long a dose is needed to kill, say 50 per cent. of the eggs, we can estimate the intensity with considerable accuracy. Half the eggs are killed by 180 r units. If 10 minutes are required to kill this proportion, the intensity was 18 r/min.

The wave-lengths employed lay within the range of ordinary radiotherapeutic practice, that is, they were produced at potentials of 50 to 180 KV. But now that machines capable of running at much higher voltages are being developed it is necessary to determine whether a definite dose of these very short waves is biologically equivalent to an equal dose of longer waves. We have recently made this test at the California Institute of Technology where a tube which operates at 550 KV is in use.[3]

In these experiments the X-rays were filtered through 6 mm of steel, the emergent beam having an effective wave-length of 0.04 A. U. Ionization tests showed that at the point where the eggs were exposed the intensity was 15 r/min. This includes a small amount of scatter from the walls of the room, amounting to perhaps 1 r/min. The eggs were given 120, 180 and 240 units. From the curve we should expect the percentages of eggs killed to be 22, 50 and 67 per cent. The actual results, which are averages of many tests

[1] Packard, C., *J. Cancer Res.*, 1927, 11, 1.

[2] Packard, C., *J. Cancer Res.*, 1927, 11, 282.

[3] Lauritsen, C. C. and B. Cassen, *Phys. Rev.*, 1930, 36, 988.

involving some thousands of eggs, were 23, 49.5 and 68.5 per cent. Obviously then the fly eggs react to doses of these very short waves in precisely the same way as they do to softer radiation. A further test at 300 KV (0.07 A. U.) demonstrates the same fact.

Another experiment with a different biological material gave similar results. A mouse tumor (Sarcoma 180) was cut into small pieces which were radiated and then inoculated into healthy animals. The criterion of effect was the failure of the radiated pieces to grow. Untreated particles always "take." A number of tests at 550 KV showed that the lethal dose was about 2750 r. This is the same as that found by Wood[4] who used much softer rays (0.20 and 0.70 A. U.).

The conclusion is that between 0.04 and 0.70 A. U. the biological effect of equal doses is the same. How far this equality extends in the direction of still shorter waves, *e.g.*, the gamma rays of radium, and of very long waves produced at a few thousand volts, is still to be determined. Since the effect is produced by secondary radiations generated when the primary radiation is absorbed, it may be expected that there will be an equality through a much wider range of wave-lengths than have thus far been used. Experiments on the action of the Grenz rays whose wave-lengths are from 1.0 to 2.0 A. U. are now in progress.

Because of the great penetrating power of the high voltage rays it is possible to deliver to deep lying tissue a much larger proportion of the incident energy than is possible with less penetrating rays. Theoretically this should be of value in therapy; whether such rays will prove advantageous in practice can be determined only by careful study of the reaction of the patients.

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THE CORTICO-ADRENAL HORMONE

AN outstanding advance in the physiology of the internal secretions has been made by the development in the past year of potent aqueous extracts of the adrenal cortex. Nearly simultaneous announcements of the maintenance of adrenalectomized animals in perfect health by the administration of cortico-adrenal extracts has been made by Hartman and his collaborators at Buffalo,[1] and by Swingle and Pfiffner at Princeton.[2] The latter observers kept several of their cats alive and in good health over 100 days; Hartman reports that three of his animals lived over 100 days, and one over 200 days. The insignificant effect of cortico-adrenal extracts which have been developed by previous workers has been dealt with at length in a recent review.[3]

In this laboratory we have recently made and tested cortico-adrenal extracts prepared according to the methods of both the Buffalo and the Princeton investigators. The method of Swingle and Pfiffner, although long-drawn-out (taking usually 10 to 14 days) and offering many possibilities for the loss of potency to occur, is simple to carry out; that of Hartman takes only a few days but offers technical difficulties, particularly in the elimination of inert lipoid substances and of adrenalin. On adrenalectomized cats we have tested to date eighteen batches of extract made according to the Swingle-Pfiffner technique, and six batches prepared after Hartman's method.

It can be said positively that the Swingle-Pfiffner extracts contain significant amounts of the cortico-adrenal hormone. On administration of the substance to adrenalectomized cats the life span is at least much prolonged, and may possibly be extended indefinitely. The animals gain in weight and look apparently normal. We have given particular attention, however, to the recovery of animals from the severe symptoms of adrenal insufficiency, and have therefore stopped administration of the extract three or four weeks after adrenal removal, and often earlier. Evidences of resuscitation of adrenalectomized cats from extreme prostration following intraperitoneal injection of the Swingle-Pfiffner extract are apparent in 15 to 30 minutes: convulsions are suppressed, the animals show an interest in their surroundings and attempt to sit up; within an hour or so they may walk about and appear practically normal, and two hours after injection they may take food. Examples of recovery are given from a few of our protocols in Table 1.

We have made up the extract to a final concentration of 30 grams of cortex per cubic centimeter—or 100 cubic centimeters of extract per 4 kilos of fresh ox glands. The injections have chiefly been given intraperitoneally. Usually it has been necessary to inject from 5 to 10 cc of extract per kilo body weight of the animal, in the course of 24 hours, to effect restoration from the pronounced symptoms of adrenal insufficiency. Twenty cc of the extract given intraperitoneally to a small (two-kilo) cat have produced no ill effects. The material is also non-toxic when given subcutaneously, intramuscularly, intravenously or intracardially. In one case injection by the latter route was strikingly effective in resuscitating a coma-

[4] Wood, F. C., *Radiology*, 1925, 5, 199.

[1] F. A. Hartman, K. A. Brownell and W. E. Hartman, *Amer. J. Physiol.*, 95: 670, 1930.

[2] W. W. Swingle and J. J. Pfiffner, *Amer. J. Physiol.*, 96: 153, 1931.

[3] S. W. Britton, *Physiol. Reviews*, 10: 617, 1930.

TABLE I

Date	Cat no.	Condition before extract was given	Results
11/21/30	257	In convulsions	Improved in 30 minutes; walking about in 1 hour; eating 2 hours after injection
12/ 5/30	273	In convulsions	Improved 30 minutes after injection; in splendid condition 6 hours later
12/ 7/30	273	In convulsions	Again rapidly resuscitated following administration of extract
12/10/30	273	Comatose	Sat up 15 minutes following injection; appeared normal 1 hour later
12/11/30	273	In convulsions	Recovery from extreme prostration in 4 hours
1/28/31	276	Comatose	In splendid condition 5 hours after injection
1/30/31	276	In convulsions	Appeared normal within 3 hours; ate salmon

tose animal. We have also used the extract subcutaneously and intramuscularly in man without ill effect.

Our extracts made according to the Swingle-Pfiffner method contain from one-in-one-million to one-in-two-million parts of adrenalin. By control experiments we have shown that the recoveries are not due to adrenalin activity, although we have frequently found the adreno-medullary hormone effective in restoring severely prostrated animals to an apparently normal condition. Much larger amounts of adrenalin than are contained in the cortical extracts must however be given. The restoration with adrenalin is, furthermore, only temporary, lasting usually from 4 to 12 hours. Similarly the recovery from prostration following the injection of glucose solution is very short-lived. We are in definite disagreement with the statement of Swingle and Pfiffner[2] that adrenalectomized animals with severe symptoms show no improvement in their condition and "derive no benefit from the injections" of adrenalin.

It may be noted that the quantity of extract it is necessary to give to prostrate adrenalectomized animals to effect complete restoration represents relatively huge amounts of cortical tissue—a thousand times or more than the amount present in the normal cat. Swingle and Pfiffner, as well as ourselves, frequently gave from 15 to 32 cc of the extract, representing up to nearly 1,000 grams of the adrenal cortex, in the course of 12 hours, to resuscitate animals with severe symptoms. And the normal cat possesses only from 200 to 300 milligrams of cortico-adrenal tissue altogether! It seems likely that previous observers may not have secured noteworthy effects with their cortical extracts because of failure to employ the heroic dosage necessary.

Our experience with cortico-adrenal extracts made according to the Hartman technique is somewhat limited, because of the difficulties of preparation mentioned above. The few batches we have prepared we have tested a great number of times on adrenalectomized cats, and in some cases we have obtained indications of the presence of the hormone in the Hartman extracts.[4]

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PREMATURE REVERSAL OF HEART-BEAT IN BOMBYX

IT is now well known[1] that in Lepidoptera as in Ascidea there is a regular alternation in the direction of heart-beat, which, in insects, begins in the prepupa and continues during the pupal and adult stages. It is understood, of course, that the direction of heart-beat in most insects is forward, toward the head.

Intermittent backward beating does not normally occur in the full-grown silkworm until it has stopped feeding, evacuated its intestine, spun its cocoon and rested about 24 hours. Then, about 48 hours before pupation, periodic reversal of direction normally begins.

Yokoyama,[2] 1927, has recently stated that this change in type of circulation can be brought on prematurely by closing the posterior pairs of spiracles with enamel paint or by injecting lactic or acetic acid into the 8th abdominal segment. His published graphs apply to the full-grown silkworm during the 5th stage, though he claims to have obtained almost identical results with larvae of the 4th. To induce reversal, according to this observer, 6 pairs of spiracles must be blocked at the beginning of the 5th stage (one day after moulting), one pair less on each successive day, until during the last 5 days (including the period of spinning) only the 3 most posterior pairs (segments 6–8) need be blocked. Similar results

[4] Grateful acknowledgment is made of aid in the above investigations by the Grants-in-aid Committee of the General Education Board.

[5] Porter Fellow in Physiology.

[1] J. H. Gerould, *Jour. Morph. and Physiol.*, 48: 385–429, 1929.

[2] T. Yokoyama, *Dobutsagaku Zachi* [Zool. Mag.], 39, No. 459, Suppl.: 45–51, 1927.

were obtained by injecting lactic acid into the 8th abdominal segment, an n/3 solution being necessary at the beginning (one day after the moult) but only n/6 or n/7 after the first day.

Repeating and extending these experiments in July, 1930, I found that the methods used paralyzed the muscles of the body wall and heart and thus suspended forward beating. When recovery took place, a few backward beats ensued in some individuals, but the tendency to beat forward was so strong that in the unevacuated larvae of the 5th stage either forward beating exclusively was resumed or none at all.

In a large individual of this stage (6 cm in length), for example, the 6 posterior pairs of spiracles were blocked with Brunswick black at 5 P. M. on July 11. Forward beating continued, and at 10 A. M. the next day only forward beating was observed. At 3 P. M. a second coat of enamel was applied to the same 6 pairs of spiracles (segments 3–8) and in addition those of the 2nd abdominal segment were blocked. Circulation forward clearly continued. The muscles of the abdominal wall and prolegs were paralyzed; head and thorax were active. Twenty-four hours later (4 P. M., July 13) there were occasional pauses in forward beating but no reversal.

With older worms which had evacuated the intestine and were about to spin, blocking 3 or 6 pairs of spiracles was somewhat effective in inducing premature reversal, and, if one wraps cotton swabs about the tips of a pair of forceps, dips them in ether, strong alcohol or xylol and holds them against the last three pairs of spiracles (6–8 abdominal), periodic reversal at this stage can be readily induced. Backward beating was more distinct under these conditions than when the spiracles were closed with Brunswick black. A phase of 12 backward beats was counted in one case. In another (after ether), a backward phase continued for 30 minutes, but, as soon as the effect of anesthesia disappeared, exclusively forward beating was restored. Xylol was applied to the 3 most posterior spiracles in a spinning larva: a short pause in peristalsis quickly ensued and then 162 backward beats were observed. Afterwards the heart beat was forward persistently and an attempt to reverse the direction by applying alcohol to the 5th segment (segments 6–10 being paralyzed) failed.

These experiments indicate a strong neuromuscular metabolic gradient from the posterior end of the dorsal vessel. That such control is localized in a ganglion within the walls of the posterior end of the vessel is made improbable by the following experiment upon the individual in which the long-continued backward phase (30 minutes) had been induced by etherizing the posterior segments. The 6th abdominal segment was tightly constricted by a strong thread and, five hours later, the posterior end of the body (abdominal segments 7–10) was amputated. Forward beating without reversal was observed for over a half hour. Evidently forward peristalsis is produced by no special sympathetic ganglion at the posterior end. Nor is the presence of the ventral nerve cord necessary, for peristalsis continues when the dorsal body wall is excised with the heart upon it.

The injection of an aqueous suspension of carmine through the caudal horn in a larva ready to spin was followed by a phase of vigorous backward beating, after only feeble backward beats had been induced in this individual by etherizing the last 3 pairs of spiracles. The impingement of the irritating fluid upon the aorta, with its now heightened irritability, produced a reflex like the action of an emetic.

Yokoyama found that immersion of the rear end of a mature larva in water induced premature reversal. Repeating this experiment, the 3 posterior pairs of spiracles being immersed, I observed, after peristalsis had stopped and recovery was beginning, a few feeble backward beats. Six were counted after one immersion, upon complete recovery from which, constant forward beating was reestablished. To one individual a series of 3 immersions was given, after two of which a few backward beats were observed.

Immersion in 95 per cent. alcohol covering the last 3 pairs of spiracles was more effective. Nine backward beats of more pronounced character were counted in one case.

It has just been shown that amputation of the posterior segments (7–10, abdominal) does not interfere with normal forward peristalsis of the dorsal vessel in the larva, and the heart upon the excised dorsum of the adult reverses periodically.[3] It would be expected, accordingly, that the amputated abdomen of the pupa would show periodic reversal. Such was found to be the case, as the following experiment shows.

A slip-noose of strong thread was drawn tightly around the 1st abdominal segment of a soft pupa immediately after shedding the larval skin, and the head and thorax were clipped off. Central beating or double action (a form of backward beating) occurred in the abdominal heart before and during this operation. Holding the squirming abdomen after a few minutes between thumb and fingers to control the intense muscular action, it was seen that completely backward phases from the 2nd abdominal segment were alternating with forward phases. Another isolated abdomen prepared in this way was kept alive 24 hours after amputation and 42 hours after con-

[3] *Jour. Morph. and Physiol.*, 48: 422, 1929.

striction and virtual separation from the thorax. Normal periodic reversal was observed several times throughout this period. It is clear that head and thorax are not necessary to initiate backward beating of the dorsal vessel.

Since Japanese lacquers are different from the American, it may be possible that the enamel paint used by Yokoyama would have a different effect from that produced by our Brunswick black and so induce backward beating in the less mature larva. It should be noted, however, that local paralysis in the less mature larva brought on by the use of Brunswick black often did not check forward beating. The insect apparently had not reached the stage of development at which backward beating was possible; so that, upon partial recovery from the operation, only forward pulsation occurred. In the more mature larva ready to spin, narcotization of the posterior segments, if not intense, still inhibits very imperfectly the strong tendency to beat forward.

That minute quantities of acid added to Ringer's solution quickly paralyze the dorsal vessel of the larva was shown by Pigorini,[4] 1917, who found that acetic acid at a dilution of $\frac{1}{1000}$ and formic acid at even greater dilution ($\frac{1}{5000}$) were instantly lethal.

To solve the problem of backward beating one should first answer the fundamental question, why it beats forward. Evidently there is a pronounced metabolic gradient from the posterior end of the larva which is never lost and only intermittently neutralized. To it, as development proceeds, is added the condition in which the middle region (young pupa) or the aorta (adult) are intermittently more active. These gradients are adaptations to the great influx of hemolymph (1) into the posterior end of the heart, (2) into the region of the node of double-action or central beating in the young pupa (usually between abdominal segments 3–4), and (3) from the thorax, with its pulsating mesothoracic vesicle, in the older pupa and adult.

Summary

(1) Premature reversal of direction of heart-beat in *Bombyx* was induced in spinning larvae and those about to spin by blocking the 3 most posterior pairs of spiracles with Brunswick black, in accordance with the experiments of Yokoyama.

(2) This method and the injection of lactic and other acids paralyze the muscles of the body wall and heart in that region, thus preventing forward and permitting backward beating.

(3) Attempts to produce periodic reversal in the larva in the early days of the 5th stage by Yokoyama's methods failed.

(4) The application of ether, alcohol, or xylol to the 3 posterior pairs of spiracles, or immersion of these segments in alcohol, was effective in inducing premature reversal at the close of the 5th stage, exclusively forward beating being resumed as soon as narcosis disappeared.

(5) Amputation of the posterior end of the body of the larva, including the end of the dorsal vessel in abdominal segments 7 and 8, did not prevent forward peristalsis.

(6) Amputation of head and thorax from the abdomen of a pupa did not interfere with normal periodic reversal in the abdomen.

(7) Thus periodic reversal in the dorsal vessel takes place without the intervention of any terminal ganglia.

(8) The suggestion of Yokoyama and earlier writers (Bataillon, Fischer) that general acidosis initiates normal backward beating is not corroborated.

(9) The metabolic gradient of the larval dorsal vessel is never lost, but intermittently neutralized in the prepupa, pupa and adult by increased metabolic action at two other points: the central node (in the young pupa) and the aorta with its mesothoracic pulsating vesicle (in the adult).

(10) These gradients are adaptations to the large influx of hemolymph into the dorsal vessel at three principal regions.

The writer gratefully acknowledges assistance rendered by a grant from the Joseph Henry Fund. Useful suggestions by Dr. C. C. Stewart were incorporated in this article during its revision.

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[4] Atti. R. Acc. Lincei, Anno 314, Ser. 5, Vol. 26, 2° Semest., p. 15–19, 1917.

AMOEBOID MOTION AS THE PRODUCT OF PROTEIN SWELLING

THE nature of protoplasmic movement, as seen in its simplest form in the extrusion of pseudopodia by the amoeba, is still a matter of debate. Whether we deal with the apparently haphazard actions of the free-swimming amoeba or the directional movement of a leucocyte, the fundamental nature of and the reason for the movement remain obscure. The most popularly accepted belief is that the amoeba suffers a surface tension change, but the material in which such surface tension change occurs has never been touched upon to my knowledge. It occurred to me that the extrusion of a pseudopodium by an amoeba might depend upon a localized swelling with consequent softening of a surface area in a properly "stim-

ulated" animal; this giving rise to inequalities in tension within the total organism and resulting in an extrusion of protoplasm at the point of stimulation and a movement in the direction of its source.

Since proteins constitute the essential hydrophilic colloid which makes up the living cell and since we are familiar with a series of chemically well-defined substances which make such proteins swell, the effects of these substances in evoking protoplasmic movement were studied. *Those materials which are known to be hydrators of proteins will, when properly employed, lead to the extrusion of pseudopodia by amoeba and a movement of the organism in the direction of the "stimulus."*

I found that a stock amoeba, grown in an aquarium, would come to rest in approximately spherical form after two washings and a rest period of thirty minutes in a .3 per cent. sodium chloride solution. Transfer was made by means of a capillary pipette in order that as little as possible of the aquarium water might be transferred.

In each of the following experiments a single amoeba was placed in a hollow-ground slide carrying 0.25 cc of the salt solution. The exact position of the amoeba was followed by the insertion of a double-ruled glass disk in the eyepiece of the microscope. This ruling yielded a square, approximately the size of an amoeba, with eight lines radiating from it, each pair of which bounded a lane along which the chemical solutions employed might be introduced and the swelling observed. The solutions were introduced from a capillary pipette fitted with a rubber bulb.

When .005 cc of 5/N HCl is introduced close to an amoeba which has reached a state of inactivity in a sodium chloride solution, the animal responds by sending out a process toward the acid. The whole amoeba may be observed to move toward the acid. After such initial and directional movement and after the acid has had time to diffuse, pseudopodia may be sent out in haphazard fashion over larger areas of the stimulated surface. If, after such treatment, the amoeba is returned to its normal habitat, it moves about normally.

Lactic, acetic and sulphuric acids act similarly when employed in the same amount and strength.

While all acids increase the hydration capacity of protein colloids, they show a large quantitative difference and this difference does not follow their dissociation in aqueous solution or the concentration of the hydrogen ions they yield, but is specific—hydrochloric, lactic, acetic and sulphuric acids, for instance, are effective in the order named when compared. *The same is true of their effects in eliciting amoeboid motion.*

In the same amount hydrochloric acid is effective at a concentration of N/4, lactic acid at N/2, acetic acid at 1/N. Sulphuric acid is not effective until a concentration of 5/N is reached. In the case of each acid the speed and amount of reaction of the amoeba is increased as the concentration of the acid is increased.

Urea, the amines and the alkalies are among the substances which act as hydrators of proteins. *These all have the property of inducing amoeboid movement.*

A crystal of urea (weight – 0.001 gm.) acts in the same manner as the acids.

Paraphenylenediamine proved to be the most satisfactory of all the agents which I studied. This substance dissolves so slowly that the amoeba may be observed to migrate in the direction of the crystal. The movement is slow and flowing in character and differs in no respect from "normal" amoeboid movement. The amount used was the same as in the case of urea. If, after such treatment, the animal is returned to its normal habitat, it moves in a "normal" manner.

When 5/N NaOH is used in the same manner as the acids, the amoeba responds in the same way.

All inorganic salts antagonize—even without chemical neutralization—the swelling effects of acids upon protein colloids. They do this in a definite order, univalent radicals being less effective than divalent at the same molar concentration, and these than trivalent. *The same is true of amoeboid movement.*

In this group of experiments the amoeba was permitted to come to rest in .3 per cent. sodium chloride solution and then placed in .25 cc of a solution of the salt to be tested; .005 cc of 5/N HCl was used as a "stimulus" in each case. Ferric chloride produces complete inhibition of movement at a concentration of .05/M; calcium chloride and magnesium chloride between .1/M and .2/M; while sodium chloride does not produce this effect until a concentration of .6/M is reached. For any given salt the response of the amoeba to the "stimulus" decreases as the concentration of the salt solution increases.

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BOOKS RECEIVED

CASTELLANI, SIR ALDO. *Climate and Acclimatization.* Pp. viii + 152. 5 figures. John Bale Sons and Danielsson, London. 7s/6d.

FARNHAM, C. MASON. *Determination of the Opaque Minerals.* Pp. vii + 236. McGraw-Hill. $3.50.

RAYLEIGH, LORD. *Lord Balfour in his Relation to Science.* Pp. viii + 46. Cambridge University Press. Macmillan. $1.00.

THWING, CHARLES F. *American Society.* Pp. ix + 271. Macmillan. $2.25.

WOODMAN, A. G. *Food Analysis:* Typical Methods and the Interpretation of Results. Third edition. Pp. xii + 557. 110 figures. McGraw-Hill. $3.50.